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Contents.

	PAGE
Foundry Costing	161
A Foundry Costing System	162
Correspondence	165
Ideal Home Exhibition	165
Institute of British Foundrymen	166
The Heat-Treatment and Growth of Cast Iron	167
Training Young Foundrymen	172
The Resistance to Wear of Cast Iron in the Case of Sliding Friction	173
German Engineers Discuss Electrical Furnace Practice	175
Molybdenum in Steel	177
Odd Jobs	178
A Review of Foundry Conditions	180
Staffordshire Iron and Steel Institute	182
Trade Talk	184
Iron and Steel Markets	186

Forthcoming Events.

FEBRUARY 21-MARCH 4.

British Industries Fair, London.

FEBRUARY 25.

Institution of Engineering Inspection:—"The Economic Production of Steam by Electricity," Paper by C. J. Wharton, O.B.E. (member of Council and Hon. Secretary of the Institution).

MARCH 1.

Institute of Metals (North-East Coast Local Section):—Annual general meeting at Newcastle-on-Tyne.

MARCH 3.

Institute of Metals (Birmingham Local Section):—E. W. Smith, D.Sc., F.I.C., "Metal Melting Furnaces." Joint programme arranged by the Birmingham Metallurgical Society, the Staffordshire Iron and Steel Institute.

Institute of British Foundrymen.

FEBRUARY 26.

East Midlands Branch:—Ordinary meeting at Leicester. "Science and the Foundry." Paper by A. Castle.

Newcastle-on-Tyne Branch:—Meeting at Newcastle. "The Holley Permanent Mould." by D. Sharpe.

Sheffield Branch:—Visit to Metropolitan Vickers Electrical Company, Limited, Manchester.

MARCH 5.

Lancashire Branch:—Joint meeting with West Riding of Yorkshire Branch at Rochdale. "The Foundry Cupola." Paper by W. H. Poole.

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES EQUIPMENT AND SUPPLIES ASSOCIATION.

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Secretary: F. J. Griffiths, 20, Fisher Street, Swansea.

Foundry Trades Equipment & Supplies Association.

Secretary: K. S. Bridges, Avenue Chambers, Southampton Row, London, W.C.1.

Foundry Costing.

Opinion is practically unanimous that the most urgent matter necessary for true progress in the foundry industry is the change over from a guesswork to a mathematical basis for costing. We are not convinced that any foundryman would cut his prices beyond an economic limit, if he knew definitely that he was losing money by doing so. Quite often he has some vague notion of keeping down his overhead costs by so doing, but it is, except in the hands of experts, a very dangerous proceeding.

Elsewhere in this issue, Mr. A. W. G. Bagshawe develops a system of recording costs which provides data for estimating purposes on reasonably accurate grounds. We can imagine that a certain number of our readers will find an almost unlimited number of reasons why the system is not applicable to their own particular foundries. They are of a type which immediately takes up an unreasonable, antagonistic attitude to any extra-mural innovation. For many years now foundrymen have been in the habit of ascertaining the cost of metal, either at the cupola spout or in the ladle. We fail to see any particular advantage in creating any arbitrary stopping-place for the finish of expenses to be included in any one section. The object of a costing system is to enable the sales department to quote for work on a remunerative basis, and we agree with Mr. Bagshawe's implied hypothesis that the foundation of any method should be the annual total divided by the annual consumption plus or minus an allowance for market-price variation, because it takes care of all losses, whether melting, absorption by the sand, or fettling. Factors, such as rebricking cupolas, heating and lighting, which are not the same in every month throughout the year, are borne by every casting made. Like most other systems, a certain amount of judgment has to be used in its application to estimating. If by a very complete method an exact cost-price figure was arrived at, it is fairly certain that it would be extravagantly expensive. The system outlined costs about 3½d. per cwt., and we doubt if ever anybody ever lost an order for so small a difference in a quotation. With a jobbing foundry it would naturally be a little higher.

Perhaps the best feature of Mr. Bagshawe's system is the way it takes care of the overhead charges. Many foundries have some method of splitting these by charging different percentages—varying with the complexity of the casting—to the metal and the labour. No doubt this is definitely a good method, if it can be shown that the cost of running a concern varies in some relation to the proportional cost of metal and the labour employed in fabricating it to the form of a finished casting. A modification which appears to us as desirable is the utilisation of curves which would show the trend of the total expenses of running the foundry with increasing tonnage output, and also the labour costs with varying output.

The weakness of all costing systems is that they are unable to take care of violent fluctuations, such as coal strikes, or a radical change in policy. In the case of the former, there is usually a serious rise in the cost of materials, which can easily be included, but increases in waster losses through the utilisation of unsuitable material are difficult of estimation. In the latter case it may be decided to increase the sales staff by several thousands of pounds per annum. By Mr. Bagshawe's system a year's credit is given for such contingencies, and by the end of this period corresponding credits should begin to show themselves.

XUM

A Foundry Costing System.*

By A. W. G. Bagshawe.

In giving this Paper a practical system has been sought which can be operated in a small or medium sized foundry without incurring excessive expenditure, that is, a system which will show the information required without absorbing the best part of the profits. There is a story told by an American gentleman who was reading a Paper in the United States also on Foundry Costing. He was going round a works in which they had a small steam locomotive which has a most powerful and penetrating whistle. After duly admiring the whistle he was informed that it took so much steam that he would have to wait quite a long time before he could see the engine start.

That is the first important principle of a costing system. The cost of operating the system must be in reasonable proportion to the output of the foundry, and to the profits which are or should be derived from that foundry. If the costing system reduces the cost of production by just enough to pay for itself, it is worth having. It is a poor system that cannot do better than that.

Basis Divisions.

Foundry costing can be divided into two broad headings which are very closely allied. They are (1) general or average cost and (2) individual order costs.

By "general" or "average" cost is meant, as an example, a total year's production of, say, 1,200 tons at an average price of, say, £20 5s. a ton, and by individual order costs reference is made to the case of a customer's order for so many castings costing either so much the lot or so much a hundredweight.

General or Average Costs.

In making up "general" or "average costs," it is essential that the period over which they are taken should be considered. In the Author's own foundry costs were originally taken every month, and some very peculiar results and fluctuations were obtained. These fluctuations were due to a number of simple things in themselves, but the aggregate made the total cost very unreliable. For instance, every man paid weekly had to have his wages dissected part to one month and part to the next. This involved extra work and liability for error. In another case the cost of heating and electric light which only occur in the winter months made difficulties.

Any abnormal running repair, such as a new cupola lining, was liable to make the cost for one month look excessively high. The remedy was to divide up the expenditure over a number of months, but it was complicated and mistakes were easily made.

To overcome these troubles it was decided to take out an average cost once every three months. That was a distinct improvement, so it was later changed to every six months, and finally to once a year.

FIXED COSTS *Not Affected By Output*	VARIABLE COSTS *Depending On Individual Castings*	ORGANIZATION EXPENSES *Remaining Stationery With Varying Output*
PIG IRON.	MOULDING.	FOREMEN &
PURCHASED SCRAP.	CORE MAKING.	CHARGE HANDS.
COKE.	GRINDING.	LABORATORY EXPENSES.
NEW MOULDING SAND.	FETTLING.	RATES & TAXES.
COAL DUST.		REPAIRS TO BUILDINGS.
BLACKINGS.		REPAIRS TO PLANT.
GANISTER.	PATTERN WORK.	DEPRECIATION OF PLANT.
CUPOLA BRICKS.		LIGHTING.
SMALL TOOLS.		HEATING.
MOULDING BOX REPAIRS.		FIRE INSURANCE.
ABRASIVE WHEELS.		W.C.A. INSURANCE.
CARTING.		FOUNDRY MANAGEMENT.
POWER.		CLERICAL WORK.
CORE SAND.		PRINTg & STATIONERY.
CORE BINDERS.		COSTING DEPARTMENT.
		PATTERN REPAIRS

FIG. 1.—MAIN SECTIONS AND SUB-DIVISION FOR FOUNDRY COSTING.

Annual Cost as Basis for Calculation.

A yearly cost gives more reliable information than a half-yearly one. It is less expensive from the recording point of view. It covers such seasonable items as heating and lighting, also insurances, annual holidays and many others, which in a shorter period would have to be estimated and to a certain extent guessed if the final cost is not to vary to any unnecessary extent.

Sectionising General Costs.

A "general" or "average cost" may, it is generally agreed, be divided into three main sections, each capable of being subdivided into a large or small number of subdivisions at will.

Fig. 1 gives the three main sections with a few suggested subdivisions under each. In actual working the Author prefers more of these sub-items, but that is a matter which each man must settle for his own foundry and conditions. The greater the number of sub-items, the more exact will be the knowledge of the way the money goes, and the greater the opportunity of checking waste.

These main sections are reasonably distinct, but from time to time occasions will arise in which it

* A Paper read before the London Branch of the Institute of British Foundrymen, Mr. R. Shaw presiding. The Author is Chairman of Messrs. Bagshawe & Co., Ltd., of Dunstable.

is difficult to decide into which division an item should be recorded.

1st Group: Definite Fixed Costs.—These are cost accounts in which the cost of a ton of finished castings is not to any great extent affected by variations in tonnage. In other words, if you buy pig-iron for £5 a ton, it will still cost £5 a ton whether you make 10 tons or 20 tons or 100 tons a week.

2nd Group: Variable Costs.—These are mainly labour accounts and are seriously affected by the size, shape and difficulty of manufacture for each separate casting; also by the quantities required. It is common knowledge that two castings of the same weight need not cost the same. One may supply on one day, but it has been shown in this way to reduce it to reasonable dimensions.

The record starts on January 1, with a stock of 1,050 tons, which has cost £5,775, or an average of £5 10s. per ton. The weight, 1,050 tons, is the stocktaking figure, and can be obtained in two ways:—(1) By actually weighing the stock—a very expensive and troublesome job in a large foundry, and (2) by keeping every truck of iron received in a separate place in the stock yard, if space permits. This method will appeal to the metallurgist and laboratory. If there is not enough space for each truck, a number of trucks may be kept together, but an *exact* record of the contents of each pile must be kept.

PIG IRON Jan 1926 - Dec 1926

Date	Received Tons	Cost Per Ton	Total Value			
Jan 1	1050	5-10-0	5775	0	0	Brought Forward from 1925
14	120	5-0-0	600	0	0	
21	25	6-0-0	150	0	0	
Feb 17	90	5-10-0	495	0	0	
Mar 27	120	5-5-0	630	0	0	Jones & Smith
April 4	100	5-15-0	575	0	0	
May 21	210	5-0-0	1050	0	0	
June 19	150	5-0-0	750	0	0	Empire Iron Co
30	60	6-10-0	390	0	0	
July 10	180	5-10-0	990	0	0	
Aug 17	120	6-5-0	750	0	0	
Sept 18	220	5-10-0	1210	0	0	
Oct 19	110	6-0-0	660	0	0	
Nov 2	50	6-10-0	325	0	0	
12	40	5-15-0	230	0	0	
21	80	5-10-0	440	0	0	
28	20	6-5-0	125	0	0	Robinson & Co
Dec 10	60	5-10-0	330	0	0	
21	120	6-0-0	720	0	0	
Total	2925		16195	0	0	Average Cost 5-10-9
Stock	525	5-10-9	2906	15	5	At 31st Dec 1926
	2400		13288	4	7	Cost Of Iron For Year
						Tonnage Sold 2256 Tons
						Melting Loss 144 Tons
						— do — 6%

FIG. 2.—PIG-IRON RECORDS FOR ONE YEAR.

have difficult moulding, intricate coring and expensive fettling. The other may be a plain straightforward job. The second or variable cost group has to deal with these possibilities.

3rd Group: Organisation Expenses.—Organisation costs are essentially items in which the total expenditure does not vary much whether the output of the foundry is steady or not. For instance—suppose the average foundry output is 50 tons of good castings a week. For some reason or other the output falls to 30 tons and remains around that figure for a few months. Although the sales are 20 tons a week less than average, are the local rates reduced by 40 per cent.? Does it cost any less to heat or to light the works? In nearly all these cases the weekly expenditure remains about the same.

Recording Costs.

The next illustrations (Figs. 2 and 3) are intended to represent specimen record sheets, Fig. 2 being a pig-iron record for one year.

For the purpose of this paper this chart only shows a very abbreviated number of entries. In actual practice there would be anything from five to ten times the number of entries. A foundry buying a couple of hundred tons of iron a month would not expect to receive a whole month's

Having obtained the stock, the next thing is to enter on the cost sheet every truck or consignment of iron received from the makers. This goes on to the end of the year. A large margin for notes is invaluable.

At the end of the year, including the stock brought in, there is 2,925 tons of iron, costing £16,195. By a simple division sum, it is found that the average cost of pig-iron all round has been £5 10s. 9d. a ton.

It is next desirable to ascertain how much has been used in the year. If the foundry has used the iron, it cannot at December 31 be in the stock yard. By the same reasoning, if it has not been used, the iron must be in the stock yard, as no one is likely to steal pig-iron. It, therefore, follows that the quantity used must be the quantity in stock at the end of the previous year, plus the quantity received during the year, less the quantity in stock at the end of the year. Thus the year is started with 1,050 tons. Various lots of new iron and bought scrap have been received during the year, but when stock is taken at the end of the year there is 525 tons only. It is obvious, therefore, that the foundry has used the difference of 2,400 tons.

The average value of the stock on December 31 is then 525 tons at £5 10s. 9d., or roughly £2,906.

XUM

By simple subtraction, it is found that the iron has cost £13,288 4s. 7d. over the year.

With this method of taking costs, it is not necessary to depend on daily weighings of charges to the cupola. It is usual, and really necessary, to weigh the charges for purposes of analytical control. Everybody knows what happens to these daily weighings. A charge may be forgotten, or the scales may not be read correctly, or the weight of the truck or barrow may be included, even the scales may be wrong. Metallurgists have some method of their own for overcoming these difficulties. Personal experience is that large numbers of small weighings are quite useless for accurate costing apart from the fact that the recording cost is heavy also.

There is no possibility of the system shown on Fig. 2 giving a false result unless the stock is wrong, and that should never happen.

analysis or any emergency. It is practically impossible to take a cost of any particular casting or consignment of castings in conjunction with any particular consignment of pig-iron. The fact that a foundry uses the runners and scrap from one melt in subsequent melts makes such a cost investigation almost impossible without unreasonable expense.

An exactly similar system of recording can be used for nearly every item in this group of fixed costs. It can be used for coke, new sand, coal dust, ganister and any other bulk materials. It can also be used for goods counted in quantities as opposed to weight, such as cupola bricks, abrasive wheels and even small tools like shovels and sieves.

Fig. 3 shows a similar system of recording applied to abrasive wheels. If a number of different sizes of wheels are used, a separate cost

FIXED COSTS. Abrasive Wheels — 54

DATE.		SIZE 20"x2"x2"				
1926 Jan	1	In Stock From Cost Sheet 31 Dec 1925	12	54	0	0
	10	Atlantic Grinding Wheel Co	10	45	0	0
	17	Eastern Abrasive Co	3	12	15	0
Feb	2	do	7	29	15	0
March	12	do	12	51	0	0
April	2	Atlantic Grinding Wheel Co	12	54	0	0
June	9	Eastern Abrasive Co	2	8	10	0
	11	do	1	4	5	0
	28	do	17	72	5	0
Aug	1	do	12	51	0	0
Sept	28	Atlantic Grinding Wheel Co	12	54	0	0
Oct	10	do	12	54	0	0
Nov	30	Eastern Abrasive Co	6	25	10	0
Dec	6	do	18	76	10	0
		Total @ Average Cost 87/2 ea	136	592	10	0
		Stock @ 31 Dec 1926	18	78	9	0
		Issued In Year 1926	118	514	1	0
1927						
Jan	1	In Stock From Cost Sheet 31 Dec 1926	18	78	9	0
	7	Atlantic Grinding Wheel Co	10	45	0	0

FIG. 3.—SYSTEM OF RECORDING APPLIED TO ABRASIVE WHEELS.

Melting and Fettling Losses.

The next point is to obtain the melting loss in which is also included fettling losses. Having used 2,400 tons of iron, it is found that only 2,256 tons of castings have been made. There is a difference of 144 tons, or 6 per cent.

It is thought that this figure, 6 per cent., is much lower than the usual, but that question is left for cupola experts. The point is that very many foundries have no idea of the quantity of pig-iron they buy and do not sell in a year. By examining this loss over a period of years a reasonable average can be obtained, then if one is not satisfied one must look into the melting practice. With a 6 per cent. loss it is necessary to estimate on a difference of about 21s. 3d. per ton of castings for every 20s. rise in the average price of pig-iron.

Attention is drawn to the stock figure of 525 tons value £2,906 15s. 5d. This is the starting figure for the next year, 1927, and corresponds to the figure 1,050 tons, value £5,775, which started the year 1926. Actually no attempt is made to value the stock at the actual cost price of each consignment, the stock is valued at the average price throughout the whole year. This has a particular advantage where special small consignments have to be purchased either for special

sheet should be kept for each size. The arrangement is the same as for pig-iron. One starts with the stock, quantity and total value at the end of the previous year. The wheels bought during the year are recorded from the inwards invoices, the quantity and the total value being shown. The stock is taken at the end of the year, in this case 18 wheels; the average price of a wheel is found by division, as before, giving the total value of the 18 wheels in stock £78 9s. By subtraction again, the number of wheels issued during the year is 118, value £514 1s.

On this chart the author has commenced the entry for the year 1927. The 18 wheels in stock, value £78 9s., make the first entry for 1927, and all subsequent wheels received are entered as before. The only error that can occur in this arrangement is the value of the wheels issued and not completely worn out. That is to say, at the end of 1925 there may be 10 wheels mounted on machines, all of them nearly worn out. At the end of 1926 there may be 10 wheels again mounted, all of them may be nearly new. Without going into unnecessarily costly valuation, it is not considered that this point is of sufficient importance to trouble about, and that the average over a year's trade should be sufficient to cover contingencies of this nature. Incidental information, such as the

number of pounds of castings ground by wheels can be gained from this record.

Before looking at the summary of these fixed costs, it is pointed out that any error which occurs either in calculating or in taking the stock, will automatically disappear in due course as each year starts with a new figure which is actually obtained from stocktaking. It is, however, essential that the greatest care shall be exercised in making sure that the stock figure is definitely correct when using this system. The fixed cost summary (Fig. 4) is merely a totai of a number of various cost sheets similar to the pig-iron and abrasive wheel sheets which have been shown.

(To be continued.)

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Foundry Examinations.

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—As you are well aware, I have been trying for many years now to get some education authority to set examinations for students and apprentices on foundry practice and principles. I have written both articles and letters to THE FOUNDRY TRADE JOURNAL, and have written to several authorities on the subject, and for two or three years at least it seemed to have had no effect at all. I then put the matter in front of Prof. Bullied (Nottingham University College), and he suggested I should write to the Secretary of the East Midland Educational Committee. I quickly had a reply to my letter, saying the matter was receiving attention. I am, however, pleased to say I had a letter on January 26, 1927, which stated the East Midland Educational Union have made arrangements to hold examinations in this subject for the year 1927. I have entered nine students from Nottingham University College and seven from the Ashfield Technical College, Mansfield. I should esteem it a favour if you could let this be known through the Journal.—Yours, etc.,

J. H. LIST.

The Meadow Foundry Company, Limited.
February 18, 1927.

201

FIXED COST SUMMARY

1 Jan 1926 To 31st Dec 1926

A/C No	Description	Tons Made	Total Cost £	s	d	Cost Per Ton £	s	d	
11	Pig Iron	2256	13288	4	7	5	17	10	Melting Loss 6% Average Cost 5/10/9 lbs per Ton
12	Cupola Coke		1658	18	6		14	9	379 lbs per ton melted 53/3 av
13	Sand		362	5	8		3	3	430 lbs per ton good castings
14	Coal Dust		245	1	0		2	2	70 lb av. av.
15	Ganister		225	1	4		1	11½	81 lbs per ton melted.
16	Blackings		52	0	4			6	
17	Cupola Bricks		58	10	0			6⅞	
18	Small Tools		108	1	6			11⅛	
19	Abrasive Wheels		902	7	3		8	0	
20	Carting		594	4	0		5	2¼	
21	Power		467	1	3		4	1⅛	
22	Core Sand		143	7	5		1	3½	
23	Core Binders		208	9	9		1	10	
	Total		18913	12	7	8	2	5	

FIG. 4.—FIXED COST SUMMARY.

Ideal Home Exhibition.

The eleventh "Daily Mail" Ideal Home Exhibition will be held at Olympia, London, from March 1 to March 26, and, as usual, the light castings and hardware sections of the foundry industry will be strongly represented.

THE EX-BRITISH WESTINGHOUSE ASSOCIATION is holding its ninth re-union dinner at the Hotel Cecil, Strand, London, W.C., on Friday, March 11, when Mr. L. R Morshead will be in the chair.

MESSRS. E. JOHNSON, H. Johnson and W. Johnson, brass founders and finishers, West Mount Brass Works, Pellon Lane, Halifax, trading under the style of Wm. Johnson & Company, have dissolved partnership. The business will be continued by Mr. E. Johnson.

NEWTON, CHAMBERS & COMPANY, LIMITED, inform us that their Thorncliffe Centrifugal Castings Department is now in operation on the production of general centrifugal castings. This department is engaged on the production of piston ring drums and cylindrical castings of various descriptions by the centrifugal process.

INDUSTRIAL NEWSPAPERS, LIMITED, have been elected to membership of the Association of Special Libraries and Information Bureaux.

XUM

Institute of British Foundrymen.

East Midlands Branch.

The biennial dinner of the branch was held at the Great Central Hotel, Loughborough, Leicestershire, on February 12, Mr. E. Stevenson presiding.

The CHAIRMAN, having given the loyal toast, called upon MR. A. FOWLER, J.P., of Sheffield, to propose the toast of "The Institute of British Foundrymen." On reading the Institute's report, he felt they must congratulate themselves on what had been done during the 23 years the Institute had been established. Their objects must recommend themselves to their industry. They had reached the stage when all who thought about the industry realised the more they could apply scientific knowledge to the craft, the better it would be for those who controlled the industry, and better for those engaged in it. They were slowly overcoming in the engineering trade that obstinacy so prevalent 30 years ago. They ought to see that the boys who came under their control gained and not lost knowledge, as was often the case, as they all knew. They also knew how indifferent the boys seemed to be. If they could do anything to help those boys to put their technical knowledge into practice they should, and thus reduce the anxiety which came into their business. He noted they were seeking to promote an international spirit of good fellowship among all foundrymen. Fellowship was perhaps easy in the shop, but when it came to foreigners it became more difficult. If they could do what they had set out to do they would make a valuable contribution to their business. There was room for the leaders of the industry to find some way of obviating the problems and difficulties confronting those engaged in the industry.

International Relationships.

Responding, MR. V. C. FAULKNER (president of the Institute) thanked Mr. Fowler for the kind way in which he had proposed the toast and the members for the appreciative manner in which they had received it. The toast covered an association which was known and appreciated wherever metals were cast. It had made enormous progress. He doubted very much whether any other association had ever got its Royal Charter before it had reached its majority, and, what was more, was even at that stage in a condition of which they were justly proud. The Institute did not propose to stand still, and had various methods in mind to increase the membership and the general utility. Primarily an effort would be made to interest isolated members. They in the East Midlands were fortunate in having a community able mutually to discuss problems. Others were not so fortunate. Another avenue of interest was in the dominions and colonies. It would be proposed in the near future that a member living in each dominion would be made an honorary corresponding secretary, who could be able to work in the Institute's interests and increase its usefulness in the British Empire. A third avenue was that of a more intensive cultivation of foreign relationships.

The proposer mentioned the difficulties of boys in the trade. In the larger branches they were overcoming the obstacles by instituting junior sections. They found the only way was to get the boys young, and get them interested in the scientific side of the work. Once they were interested he was confident they would never lose them.

Utilising Local Talent.

The toast of "The East Midlands Branch" was proposed by MR. J. T. GOODWIN, of Sheepbridge, vice-president of the Institute. He said in their branch they had got something of which they were proud to look back upon. First of all, in the inauguration of their branch in 1914, when Mr. Gimson was taking an active interest in it, they had a most difficult time, a time which all of them appreciated, not only in the starting up of the branch, but because of the war. They now had 31 members, 52 associate members, and five associates, which he thought was a good record. He hoped they would encourage papers from their own members. It was quite true that a prophet was not appreciated in his country, but there was just as good material in their branch to-day as they could get by going outside. Whilst it was excellent to have outside views put before them, which created interesting discussions, it was better to cultivate domestic talent.

Replying to the toast, MR. STEVENSON, branch president, said the success of the branch had very little to do with the president, but it was associated with the work of the council. With regard to Mr. Goodwin's remarks about encouraging local talent in regard to papers, they had during the last two years attempted that. They had a series of short paper competitions to bring out latent talent among junior members, and had very good results. The last two years the prizes had been carried off by two members who had never written a paper before. They also held meetings in Leicester and Derby Technical Schools and the Loughborough College, and were most anxious that the students of those institutions should attend the lectures.

Detached Views Beneficial.

MR. S. H. RUSSELL, of Leicester (vice-president of the Institute), proposing the toast of "The Visitors," said he did not want to quote Henry Ford, but he could tell them of a firm which by having an efficiency expert in, who re-arranged the plant and installed some new machinery, were able to improve their output considerably. There were many other ways of improving if they would only get outside and look at things from a detached point of view, by which business could be helped and money saved. Probably part of the trouble in this connection, in the foundry, was a matter of pride. He never liked anyone to tell him he was wrong in any detail, and the same thing probably applied in the foundry. Mr. Fowler in his speech commended one of their objects, that was the international exchange of views, and seemed to think there was a great difficulty facing them in that direction. He could assure Mr. Fowler that was not so. It was surprising how prepared the different nations were to co-operate in furthering each other's interests.

Referring to the toast he said they had amongst the visitors the Mayor of Loughborough. The town had world-famed engineering works, and he had been told that in Loughborough there were only 400 unemployed.

Responses were given by the Mayor of Loughborough (Councillor A. Hibbins), and Mr. J. F. Driver, of the Loughborough Technical College.

The CHAIRMAN gave as a final toast the health of Mr. Bunting, the honorary secretary. They had, to realise his hard work, only to become president for two years. He could assure them they were not the only Institute that realised his value. Next year, just before they were to have the conference at Leicester, when Mr. Russell would be instituted in the presidential chair, Mr. Bunting was to be installed in the chair as a Supreme Grand Master of the Ancient Order of Oddfellows, which showed he was appreciated in other places besides the Institute of British Foundrymen.

In reply MR. BUNTING thanked them for the way in which they received the toast. He had two apologies for absence. One, which he received with very deep regret, was from Mr. H. H. Moore, one of their past presidents. The other apology was from Mr. Hammond, of Syston, whose works were to be visited in the near future. He would like to say a few words regarding the work in the branch. There was one side-issue, the branch-library, which helped the individual and the junior men in the craft. They had the most useful books connected with the industry and they liked the members to use the library. Another point they could congratulate themselves upon was that last year they had an average attendance of 39 at their meetings. When they considered there were only 86 members and the area went up practically as far as Chesterfield, extended down to Lutterworth, and went over to the far side of Peterborough, he thought it was a wonderful record.

The Heat-Treatment and Growth of Cast Iron.

By J. W. Donaldson, B.Sc., A.I.C.

(*Continued from page* 146.)

Growth and Volume Changes.

Two bars from each of the three irons, ordinary "O," cylinder "P," and Perlit "Pt 2," were subjected to repeated heatings and coolings for a period of 200 hours at 450 deg. C., each heating being of eight hours' duration. Similar tests were cast out at 550 deg. C. The bars which were

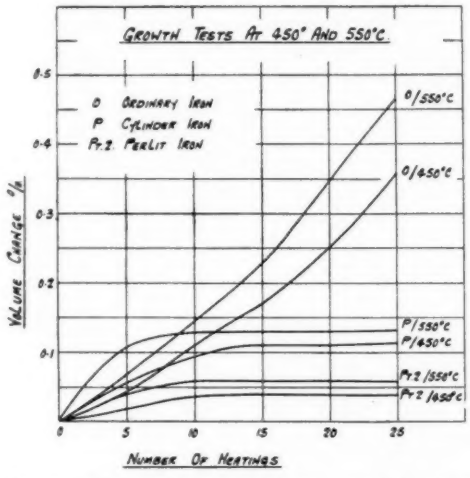


FIG. 5.—GROWTH TESTS AT 450 DEG. AND 550 DEG. C.

accurately machined to 6 in. in length and 1 in. diameter were heated in an electric resistance furnace and were accurately measured by means of a Whitworth measuring machine at the end of every five heatings or 40-hour periods. The results which were obtained are given in Tables VII and VIII and in Fig. 5.

The amount of growth which takes place both in the cylinder iron and the Perlit iron at 450 deg. C. and 550 deg. C. is small when compared with the growth in the ordinary iron. Growth in the

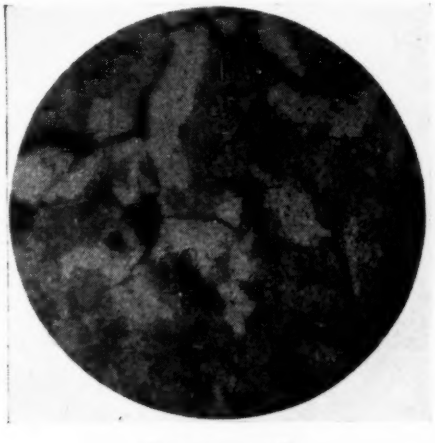


FIG. 6.—× 540.

former irons also appears to attain a maximum after 10 heatings, while in the latter the material is still continuing to grow at both temperatures after 25 heatings, or 200 hours.

That these changes are in some way related to carbide decomposition it is not difficult to surmise, but carbide decomposition alone does not explain everything. A cylinder iron containing 0.4 per cent. of chromium shrinks, yet the carbide decomposition is greater than in the case of the Perlit iron, which shows a slight increase in volume. Microscopic examination does not show any internal oxidation such as is associated with growth at temperatures above the critical range, so that the definite cause of these volume change phenomena requires further investigation.

Microscopic Examination.

An extensive microscopic examination was made on sections taken from the four irons at various stages during their heat treatment, and these, in general, confirmed the results obtained by analytical methods. To illustrate what takes place a

TABLE VII.—*Growth Tests at* 450 *deg. C.*

Cast-iron.	No. of heatings	Length.	Diam'ter	Volume.	Change.
		In.	In.	Cub. in.	Per cent.
O	—	6.0000	1.0000	4.710	—
	5	6.0004	1.0002	4.712	0.04
	10	6.0004	1.0005	4.715	0.11
	15	6.0010	1.0007	4.718	0.17
	20	6.0035	1.0010	4.722	0.25
	25	6.0052	1.0014	4.727	0.36
P	—	6.0000	1.0000	4.710	—
	5	6.0003	1.0003	4.713	0.06
	10	6.0005	1.0004	4.714	0.09
	15	6.0006	1.0005	4.715	0.11
	20	6.0006	1.0005	4.715	0.11
	25	6.0006	1.0005	4.715	0.11
Pt. 2	—	6.0000	1.0000	4.710	—
	5	6.0004	1.0001	4.711	0.02
	10	6.0005	1.0001	4.712	0.04
	15	6.0004	1.0002	4.712	0.04
	20	6.0005	1.0002	4.712	0.04
	25	6.0005	1.0002	4.712	0.04

few photographs were taken; Figs. 6, 8, 10 and 12 represent the four irons in their cast condition, and Figs. 7, 9, 11 and 13 the irons after being subjected to 200 hours' heat treatment at 550 deg. C.

The microstructure of the irons in their cast condition is what one would expect from their

FIG. 7.—× 540.

composition and process of manufacture. The ordinary iron shows graphite, pearlite, ferrite and phosphide eutectic, as also does the cylinder iron, except that the ferrite is diminished and the pearlite increased. The two Perlit irons show pearlite and graphite.

In all the irons after heat treatment the graphite plates show an increase in size, and there are evidences of graphite being deposited alongside the existing plates. This deposition of graphite is accompanied by decomposition of the pearlite which takes place generally and not in the

vicinity of the deposited graphite. This decomposition of pearlite is most pronounced in the ordinary iron, Fig. 7, where after treatment the amount of pearlite visible is practically nil. The heat-treated cylinder iron, Fig. 9, also shows case of the higher silicon iron, where there are distinct ferrite areas formed.

These microphotographs represent the extreme conditions of temperature to which the various irons were subjected. Micro-examination of the

Fig. 8.—× 540.

Fig. 9.—× 540.

Fig. 10.—× 540.

Fig. 11.—× 540.

Fig. 12.—× 540.

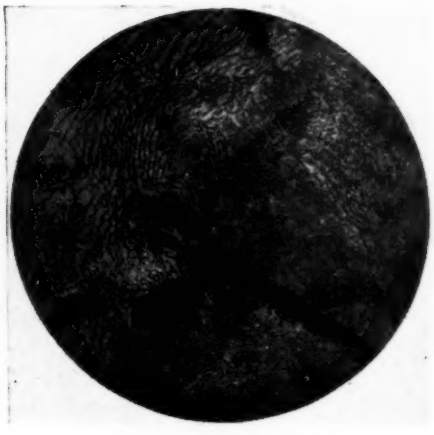


Fig. 13.—× 540.

marked carbide decomposition. Traces of pearlite are still visible, but on a whole it is disintegrated.

The two Perlit irons after heat treatment retain their pearlitic structure, although there is a distinct change in the nature of the pearlite, Figs. 11 and 13. It is of a less compact nature and has a distinctly weaker appearance. The carbide appears to be in a state of disintegration, especially in the pieces heat treated at 200 deg. C. for 200 hours shows no change in the structure. Examination of those pieces of all the irons treated at intermediate temperatures shows changes which are in accordance with the analytical results. The changes in microstructure due to carbide decomposition and graphite deposition are no doubt the cause of the falling off in strength properties of

those irons mechanically tested after heat treatment. There are no signs of internal oxidation taking place in any of the heat-treated irons.

Conclusions.

In summarising the results obtained from the various tests the following conclusions may be made, although further work requires to be done before all of them can definitely be established:—

1. Carbide decomposition accompanied by graphite deposition takes place in grey cast iron when subjected to low-temperature heat-treatment.

2. Stability of the carbide is influenced by the silicon content, and also by the initial combined carbon content. A combined carbon content of 0.9 per cent., together with an all-pearlitic structure and 1.0 per cent. or less of silicon, gives the greatest stability.

TABLE VIII.—*Growth Tests at 550 deg. C.*

Cast-iron.	No. of heatings	Length.	Diam'ter	Volume.	Change.
		In.	In.	Cub. in.	Per cent.
O	—	6.0000	1.0000	4.710	—
	5	6.0006	1.0002	4.713	0.06
	10	6.0020	1.0006	4.717	0.15
	15	6.0030	1.0010	4.721	0.23
	20	6.0046	1.0016	4.727	0.36
	25	6.0063	1.0020	4.732	0.47
P	—	6.0000	1.0000	4.710	—
	5	6.0004	1.0005	4.715	0.11
	10	6.0011	1.0006	4.716	0.13
	15	6.0010	1.0006	4.716	0.13
	20	6.0011	1.0006	4.716	0.13
	25	6.0011	1.0006	4.716	0.13
Pt. 2	—	6.0000	1.0000	4.710	—
	5	6.0005	1.0001	4.712	0.04
	10	6.0008	1.0002	4.713	0.06
	15	6.0008	1.0002	4.713	0.06
	20	6.0007	1.0002	4.713	0.06
	25	6.0008	1.0002	4.713	0.06

3. Stability is also influenced by the temperature and the duration of heat treatment. At 200 deg. C. the change is not noticeable except over a long period of time. Over 200 deg. C. the rate of change varies with the temperature and nature of the iron.

4. Carbide decomposition also affects the mechanical properties of grey cast iron according to the condition and duration of heat treatment.

5. Growth and volume changes are in some ways related to carbide decomposition, but not wholly explained by it.

The author's thanks are due to Mr. James Brown, C.B.E., and the other directors of Scotts' Shipbuilding and Engineering Company, Limited, Greenock, for permission to publish the results of those experiments, and to the North-Eastern Marine Engineering Company, Limited, Wallsend, for the Perlit test bars.

DISCUSSION.

Superiority of Perlit Iron.

MR. C. GRESTY (Newcastle) said he was a close follower of the work of Mr. Donaldson, and his interest in the Paper was increased by the fact that he was partly responsible for the production of some of the particular Perlit samples on which the experiments had been made. Ever since Perlit had been introduced into this country he had been engaged on its manufacture. The results obtained by Mr. Donaldson were, in his opinion, exceedingly valuable. In the series of Papers they had had from him in recent years they got clear and concise statements of facts without any theorising; nothing was put down unless there was proof given of it.

The most notable fact disclosed by the present Paper was the series of good and consistent results given by Perlit iron in all the tests, not only compared with the irons mentioned in the Paper that afternoon, but also with those referred to in previous contributions. Throughout the experiments good and consistent results had been obtained from Perlit, and whilst the results in the case of other irons were good in certain respects, if they were examined closely it would be found that although they did well on some tests they went down on others rather badly. For example, the iron containing tungsten, which Mr. Donaldson dealt with more fully in the Glasgow Paper, showed high resistance to growth, and iron containing chromium maintained its strength well at high temperatures, but both irons showed greater softening and carbide decomposition than the samples of Perlit. Table V, which gave the percentage alterations under different treatments, was very illuminating, and corroborated what he had just said in a striking manner. For instance, after treatment at 550 deg. C. the hardness of Perlit was only decreased by 11.5 per cent., whereas the next best iron, either in that table or in those previously published, came out at over 30 per cent. decrease. As the author pointed out, it was evident that this great stability of the carbide came from the low silicon content of the metal, because the Perlit iron had no alloy additions. He did not know whether it had come to the knowledge of Mr. Donaldson, but it would perhaps be of some interest to state that for a good many months his firm had been manufacturing Perlit iron with silicon between 0.4 and 0.5 per cent. Judging from Mr. Donaldson's results, this very low-silicon iron with 0.4 to 0.5 per cent. silicon would be even more stable than the samples with which he had dealt.

High Temperature Results.

In all his work the author had confined himself to comparatively low-temperature treatment, *i.e.*, up to 550 deg. C., and he would like to ask whether any of the irons containing additions of chromium, tungsten, nickel, and so on had ever been tested for growth above the critical point. He did not think he would be giving away secrets if he stated that Mr. C. E. Pearson, who is working at Armstrong College, Newcastle, under the Carnegie Scholarship Scheme, had been doing research work on heat treatment above the critical point, namely, at 900 deg. C. His work was in the press at present, but he had permission to mention it at that meeting. At those higher temperatures the percentages of growth were very much greater. Thus, where Mr. Donaldson might show 0.3 or 0.4 per cent. of growth at the high temperature of 900 deg. C., they would probably get 30 or 40 per cent. with the same irons. One sample of Perlit iron containing 0.68 per cent. of silicon, roughly the same as Mr. Donaldson had been working on, gave 5.5 per cent. of maximum growth. Another sample containing just under 0.5 per cent. silicon had given 2.83 per cent. growth, and of all the ordinary irons Mr. Pearson had dealt with, the lowest figure given was 16.8 per cent. of growth. Thus at these high temperatures also Perlit showed a very great resistance to heat.

Growth and Wearing Properties.

About a couple of years ago Professor Mellanby, who is an authority on iron for Diesel work, stated in a Paper that he had found from experience that the wearing properties and growth of cast iron went hand in hand so to speak. If an iron was very resistant to growth, it was also very resistant to wear. His (Mr. Gresty's) own experience of Perlit entirely bore out that statement, and he was wondering whether Mr. Donaldson had ever done any wear tests on any of his other materials.

Dealing with the micro-structures, the author stated that Perlit iron showed a pearlitic structure after 200 hours at 550 deg. C., which in his (Mr. Gresty's) opinion was rather remarkable in view of the statement that the pearlite was in a state of disintegration. It certainly had a slightly weaker appearance, but the physical tests did not show any great drop in strength. In Table V the percentage drop in tensile strength and hardness was really very low, being only 7 per cent. after treatment at 550 deg. C.

The author further stated that the actual carbide decomposition at 550 deg. C. was completed at the end of 40 hours as a general rule, so it was quite evident that that particular pearlitic structure must be very stable to enable it to persist even after another 160 hours at the same temperature.

Low Silicon Superseding Chromium.

MR. DONALDSON remarked that in the Glasgow Paper he was dealing with cylinder iron with 1.5 per cent. of silicon. Adding 0.4 per cent. of

chromium to it produced a smaller carbide change when tested under similar conditions. One of the speakers, in the course of the discussion, remarked that if the silicon was reduced from 1.5 per cent. to 0.6 per cent. a similar result would be obtained. He had obtained an iron containing 0.65 per cent. of silicon, and they saw what happened on reducing the silicon. Reducing the silicon had a greater effect than adding 0.4 per cent. of chromium.

He was not aware that irons were being made with silicon as low as 0.4 or 0.5 per cent.; he thought 0.65 per cent. was the lowest. As to high-temperature treatment, he had not carried out any tests above the critical point, his work having been confined to the low temperature. Some people, in fact, thought 550 deg. was far too high for research work in connection with Diesel engines.

He had not had an opportunity of carrying out tests on wear, and he could not therefore say how Perlit behaved under such tests. Mr. Gresty's remarks with reference to the microscopic evidence were interesting, and he agreed with them.

Producing Low Silicon Irons.

MR. SHAW (Sheffield) endorsed all that had been said regarding the value of Mr. Donaldson's work. It would appear that with a normal total carbon of approximately 3.2 per cent. it was necessary to get a very low silicon to obtain the best results both as regards strength at high temperatures and lack of growth. It would seem, at first sight, that the hot mould process was needed under these conditions (Si 0.6 per cent.) to obtain a machinable casting. Unfortunately this process was not possible in such cases as large turbines, which took several days to core up. The silicon would have to be raised to compensate for the cold mould if the casting would machine easily. This, according to Mr. Donaldson's findings, was fatal. In the competition that was taking place between the Diesel and the H.P. turbine, the latter was handicapped by lack of suitable material to give satisfaction at much higher pressures and temperatures. It was up to foundrymen to try and find a suitable iron, otherwise the engineer would find something better. He would like to suggest that it might be possible to use lower total carbon irons, with, say, chrome additions; although the silicon would need to be higher, its effect on the low total carbon (say 2.5 per cent.) would be much less and the graphite would be in a definitely finer state. It would also be possible to cast the simpler liners and piston heads in a perfectly white iron free from graphite with these low total carbons. It was possible to turn this white iron (Brinell hardness about 300) in an engineer's lathe without much trouble. These low-carbon irons could be obtained in the cupola, using about 90 per cent. steel and a 10 per cent. more of a 25 per cent. silicon pig. This consistently gave less than 2.5 per cent. total carbon. For certain purposes he used a metal containing T.C. 2.2; Si, 0.7; Mn, 0.35; S, 0.1; Cr, 1.0; and Ni, 0.5 per cent. That gave a white metal which after annealing at 900 deg. C. for 15 hours, showed no signs of graphitisation, but an altered structure that could be drilled and machined at slow speed. Whether this metal would create any difficulty in plain liners, etc., he did not know.

Importance of Sulphur Content.

He would have liked to have seen the complete analyses of the various irons given in the tables, because from a large amount of work done he had no doubt that the ratio of manganese to sulphur played a great part on the quantity and shape of the graphite, quite apart from the silicon content. That was confirmed in most shops that had to work to chill. Notwithstanding the investigations of various people who made laboratory tests on small samples and stated that any manganese above the atomic ratio to sulphur acted as a hardener, he had no hesitation in saying that they were wrong. Of course, there would be a point where excess manganese would harden a casting, but much would depend on the thickness of the casting.

Carbide Decomposition.

MR. DONALDSON, in reply, pointed out in connection with the varying of the total carbon that the irons he had worked with were more or less of the same carbon content. It was the silicon that varied. He had mentioned that he had carried out a test with an iron which had a pearlitic structure and contained 1.87 per cent. of silicon, and that after 200 hours' treatment at 550 deg. C. the carbide decomposed to the extent of 48 per cent. That iron contained 2.75 total carbon.

MR. SHAW: And what manganese?

MR. DONALDSON: I could not say.

The PRESIDENT: Was chromium added to that?

MR. DONALDSON: No chromium.

Carbide decomposition, continued Mr. Donaldson, was rather a complicated matter, because three factors were involved—total carbon, combined carbon, and silicon—and if chromium was brought in it meant a fourth. The subject required further investigation in a more systematic manner.

MR. SHAW observed that it was the manganese he was concerned with.

MR. DONALDSON replied that he had not taken that into consideration; it was varying silicon he had dealt with.

MR. SHAW: The manganese is vital.

MR. DONALDSON remarked that might be so, but, as had been previously pointed out, the only true way of carrying out research work was to vary one variable at a time, but with commercial iron it was difficult to do so because all the other constants varied at the same time. Personally he thought research carried out on commercial irons was of more practical use than that carried out on specially prepared material. Reference had been made to tests at 950 deg. C.; he had no experience of those high temperatures.

High Temperature Requirements.

He (the lecturer) considered there was a future for iron made by the Perlit process in Diesel engine work, on account of the low-silicon content which was obtained. Personally he had never seen the Perlit process in operation, and was only speaking of the samples of material prepared by it which he had received. He had had other pearlite irons prepared by different processes, but, unfortunately, he had never received sufficient bars to enable him to carry out a series of tests. Mr. Shaw had mentioned the question of temperatures in connection with Diesel engine work, and that was a factor which would have to be faced. As he had pointed out, up to 200 deg. C. it did not matter what cast iron was used so far as carbide decomposition was concerned; 200 deg. C., however, was only saturated steam temperature. Superheated steam temperatures reaching 400 C. deg. had recently been attained. He also knew of one case where an oil engine piston had been red hot, and where analysis subsequently made had shown that the temperature must have been somewhere in the vicinity of 600 deg., because there was not a trace of combined carbon left. Abnormal temperatures were met with and had to be considered. Mr. Shaw had suggested that if cast iron would not meet those conditions the engineer would turn to something else. As yet he had not done so, because there was nothing cheaper.

Low Carbon Improves Perlit Iron.

MR. GRESTY agreed with Mr. Shaw that there were processes other than the Perlit by which iron low in total carbon in the cupola could be produced. The point was if Mr. Shaw wished to make a better iron with, say, 2.5 per cent. carbon he could do so, but he could go either lower in carbon or in silicon if he adopted the Perlit process. It was not sufficiently realised that by the Perlit process they were not tied to 3.3 per cent. of carbon; they could go to 2.7 per cent. and obtain a better product than if a higher silicon were used.

The PRESIDENT said he was in agreement with Mr. Shaw that a pearlitic structure could be obtained without the Perlit process. He had done so for years, and could do so again. At the same time, if it were possible to get a more consistent material by a certain process which would lessen the responsibility of those who had to make the castings, so much the better for all concerned. The claims set up for Perlit initially were so great that they acted rather as a deterrent than an encouragement, because most people knew the claims could not be substantiated, but if it

had reduced the troubles in the foundry a little it had done something.

MR. DONALDSON remarked that he was willing to carry out tests on other pearlite irons if he could get the material, but up to the present he had had only single bars of those other irons, and that was not sufficient to carry out systematic tests.

Influence of Mn on Carbide

MR. M. L. BECKER, of the Department of Metallurgy, Manchester University, said they were privileged in hearing such a valuable Paper, embodying a great deal of recent research which had not previously been published. The problem of growth at low temperatures was receiving attention by the Cast Iron Research Association, and although it was not one with which he was intimately concerned at the moment, he knew that the value of Mr. Donaldson's work was fully appreciated.

The author was quite definite about the effect of manganese in stabilising carbide. He believed a number of people considered that at the higher temperatures manganese had very little effect upon the stabilising of the carbon. He personally had found that on annealing a white iron it graphitised proportionately rapidly according to the amount of silicon present, and that the presence of manganese up to 3 per cent. had very little effect. On the other hand, a white iron free from silicon would graphitise if annealed for a very long time, whereas an iron containing much manganese would not graphitise even in such periods as a thousand hours at 1,000 deg. C. With regard to Figs. 1 and 2, it seemed to him surprising that the effect there shown should occur, because he should have thought that as annealing progressed the combined carbon would have continued to be reduced until it fell to a value of, say, 0.1 per cent. In all irons, however, that did not seem to be the case. Decomposition took place within the first 20 hours, but the final value, which had all the appearance of an equilibrium value, was not the same in all cases even where the compositions, apart from carbon, were similar. He would like to know whether Mr. Donaldson thought this value was an equilibrium value depending upon the composition, or whether, if annealed for considerably longer periods, the combined carbon would be found to be further decomposed.

Decomposition of High Initial Combined Carbon.

The conclusion the author arrived at, that the high initial combined carbon prevented decomposition, seemed to be quite antagonistic to the general view that the higher the combined carbon of a cast iron the more it would be inclined to graphitise. In fact, the Perlit process depended on that. He was speaking of high temperatures, but one would expect the same rule to hold in cases below the critical range. In the micro-sections shown on the screen the laminations became more distinct, and apparently further apart on annealing at 550 deg. C. Was that the case?

MR. DONALDSON said he thought it was just that the section or the particular area had been badly chosen. Generally speaking, the photographs showed that, but it was not so.

Factors for Carbide Decomposition.

MR. BECKER continued that the precipitated graphite apparently migrated to the pre-existing flakes, and was, therefore, not visible in the ferrite areas of the fully annealed iron. That was a surprising fact, and was evidence of the hypothesis that the ferrite would take carbon into solution at temperatures below the critical point. The Perlit irons showed up extremely well in resisting growth and carbide decomposition, and it would be interesting to know whether Mr. Donaldson had compared a partially graphitised white iron such as might be obtained in the production of black heart malleable iron if the rate of cooling from the annealing temperature were rapid instead of slow. By treating such a material along with the Perlit and grey irons at a temperature of 550 deg. C. it might be possible to determine whether the form and distribution of the pre-existing graphite were factors influencing the rate of carbide decomposition as distinct from the silicon content. He personally was inclined to the belief that they were.

With regard to the analysis of the iron which had been subjected to heat-treatment, it was a little difficult to visualise what would happen to the precipitated graphite. If it were precipitated in very fine particles, was some of it going to escape on analysis, or did Mr. Donaldson think it would all be estimated along with the other graphite?

Relative Values for Carbide Decomposition.

MR. DONALDSON said the question of manganese was dealt with in a previous Paper. He found that 2.75 per cent. manganese added to a 1.6 per cent. silicon iron gave a stability somewhat similar to 0.4 per cent. chromium. That was the only experience he had with reference to manganese. He had no experience of white iron at all. With regard to the question of an equilibrium value it was difficult to say, but he thought there was an equilibrium value for a particular temperature. With reference to graphite he had always assumed that all the graphite deposits came out in the analyses. In doing those analyses he usually did the total carbon and the graphite, and got the combined carbon by the difference. In some cases he did the combined carbon direct, but he preferred the former method.

MR. JOLLEY asked whether Mr. Donaldson worked entirely on test pieces or had he used parts of castings, and had he at any time taken samples of ordinary irons which had been cast in the ordinary way and irons cast by the Perlit process? There was, no doubt, something in the Perlit process, but the trouble was the limitations in heating the moulds and controlling the temperatures so obtained.

MR. DONALDSON stated that the cylinder iron was taken from test bars cast separately, whilst the Pt. 1 bars were cast on a casting. Pt. 2, however, was supplied in the form of test bars, cast separately. He had tested irons made by different firms which he knew did not use the same pig-irons, because they bought from different sources, and he got more or less the same results from those different irons.

High Total Carbide Successful for Diesel Work.

MR. LONGDEN asked how the author had taken the Brinell hardness. Did he machine the test bars to a definite depth, and take it at exactly the same place in each bar? He had carried out a number of experiments in the production of pearlitic cast iron, and he did not agree with Mr. Shaw when he stated that the physical properties in other irons were equal to Perlit. The impact strength was a most important matter in Diesel engine work. If a bar of ordinary iron 1¼in. diameter was struck pretty forcibly it could be broken in a couple of blows, but Perlit iron would stand 200 or 250 blows. Why there was such a vast difference he could not say. There was an Italian firm which made a great success in the production of the Diesel engine, and particularly the breach ends. It had been brought out that low carbon was absolutely essential. Yet that particular firm made an iron with a total carbon content of 3.81; silicon, 1.36; manganese, 0.87; and sulphur, 0.28 per cent. If he were choosing metal for a heavy-oil engine, he would select Perlit iron for the breach end, the piston and the piston ring, and another iron for the liner. There was a place for all these metals.

MR. DONALDSON said that all the bars were standard test bars, and the Brinell hardness was carried out after the bar had been machined to the standard size and always at the same place.

The PRESIDENT remarked that in connection with many of the difficulties which had been referred to there was some fault on the engineering side as well as on the foundry side. When red-heat temperatures were reached it could not be expected that steel, cast iron or any ferrous or non-ferrous metal could withstand it, and it was as much the work of the engineer as of the foundryman to deal with the matter. He had seen cylinder heads taken out of an old engine showing clear signs of having been red hot. Something had been wrong in the engine apart altogether from the casting. With cylinder heads and pistons that had developed star cracks no reason was ever given for their presence, and on analysis the metal had been found to be satisfactory; in fact, very little different from when it was originally put in the casting.

XUM

Training Young Foundrymen.

The Middlesbrough Branch of the Institute of British Foundrymen, at their last meeting, listened with interest to a lecture on the "Training of the Young Foundrymen," by Mr. T. Makemson, the General Secretary of the Institute. The local Director of Education (Mr. Williams) was present.

MR. WILSON, the Branch-President, in introducing the speaker, congratulated Mr. Makemson upon his recent appointment, and assured him that the committee and members wished him every success in his new sphere.

Mr. Wilson said that from reports that had reached him concerning the General Secretary's activities, he knew that the speaker was quite a competent authority upon the subject of that night's address.

In his opening remarks MR. MAKEMSON very heartily thanked the Middlesbrough Branch for the good wishes, and hoped that he would be able to carry out his duties to the satisfaction of everybody.

How Modern Conditions Affect the Problem.

Mr. Makemson said that apprenticeship had altered considerably in recent years with the development of industry into large organisations. The personal contact between apprentice and employer was much less pronounced than a generation or two ago. The increased specialisation in industry, which was now becoming so pronounced, was having the effect of still further diminishing the contact. The apprentice had always been largely dependent for his training upon the goodwill of his fellow workmen, but under modern conditions the workman was not always able to give sufficient time to the instruction of his apprentice colleagues.

Referring to the foundry trade in particular, the speaker said that there was a distinct prejudice among many youths and parents against entering the trade. He pointed out, however, that the conditions were no worse, but were frequently better, than the conditions obtaining in many other trades, such as those of the millwright and of the building trades, but the foundry suffered from the prejudice which had arisen in the past. He stated that not only were the conditions much better than many people imagined, but the trade of the moulder offered better opportunities for advancement to the intelligent and ambitious youth than many other occupations.

Specialised Evening Classes Advantageous.

Continuing, Mr. Makemson said that a system of training for foundry workers should consist of practical training or apprenticeship in the foundry, and instruction in the underlying principles or in the technical subjects relating to the trade. Many firms had established training schemes, both practical and technical, in their own works, and he outlined a number of these schemes, and pointed out that for all but the smallest works such schemes were remunerative investments for the employer, and were of incalculable value to the worker. He also stressed the necessity of some technical training for the modern foundryman, and said that although classes were provided in drawing and elementary science and mathematics in all large foundry centres, yet he felt that in an important centre of the metallurgical industry, such as Middlesbrough, a class or classes should be provided which would give instruction in the actual technique of foundry operations. Foundry work was a specialised subject, and the future foundryman should have an opportunity of studying the fundamental scientific principles of his own craft. Classes in purely foundry subjects were being successfully run in many parts of the country, and the speaker strongly appealed to the authorities in the Middlesbrough district to consider the question of the establishment of a foundry class for the next winter.

Speaking to the young foundrymen present, the lecturer stated that although he had been discussing schemes which concerned the employer and the Education Committee, yet it was essential that the young foundryman should remember that whatever may be done for him by someone else, ultimate success depended entirely upon himself. He appealed to the young men to take advantage of the existing educational facilities, and of any further facilities that might be provided. He pointed out, however, that whether classes were provided or not, it was to their own personal advantage to take every opportunity to fit themselves to become competent leaders of the foundry industry of to-morrow. The first requirement was for them to become thoroughly good craftsmen, and this meant close application to their daily work in the foundry. Secondly, they should learn sufficient mechanical drawing to enable them to read drawings; they should also endeavour to retain the knowledge of mathematics which they had gained at school, and they should have some general knowledge of chemistry and physics. In addition to these fundamental subjects he advised all young foundrymen to study elementary metallurgy, and also to read as much as possible about current foundry practice, so that they might become familiar with methods which were employed in foundries other than their own.

Mr. Makemson finally outlined the work which was being done by the Institute of British Foundrymen, and invited all foundrymen, whether proprietors, managers, or workmen, to become members of the Institute.

DISCUSSION.

On completion of Mr. Makemson's address, an invitation was extended to Mr. Williams, the Director of Education, to address the meeting.

MR. WILLIAMS said that, in the first place, he was here to learn and not to teach. He was very much interested in some of the points expressed. The first thing essential to the success of a class was the sympathy of the management of the various firms in the district. It must also have the sympathy of the foremen, who are nearest to the young men over whom they exercise control. He regretted very much to say that although there existed in Middlesbrough a class in metallurgy, it could only boast six students—a tragedy when one remembered that our town was regarded as the centre of the iron and steel industry in this country.

Local Foundry Classes to be Formed.

Mr. Williams congratulated the Branch on the progress it had made since its inception a few months ago, and invited the members, and foundrymen in general, to assist him and his Committee in their efforts to keep alive the evening classes held in Middlesbrough.

He intimated that it was the intention of his Committee to form next winter a class for young foundrymen, which would be in the hands of a competent teacher, and if he and his Committee received the support of principals, foremen, and the young men employed in the particular industry, he would spare no efforts to make the class a distinct success. Further, if any firms were able to form works' classes similar to those mentioned by Mr. Makemson he would be very pleased to provide the necessary teachers.

In conclusion, Mr. Williams expressed his thanks for the sympathetic hearing he had received, and wished the Branch every success in its efforts to meet the needs of the foundry trade in the Middlesbrough district.

The CHAIRMAN (MR. WILSON) thanked the Director of Education for his sympathetic and most helpful remarks, and assured him that whatever movement was inaugurated for the good of the young men engaged in the local industries, such movement would have the Branch's ardent support.

MR. GREENWELL expressed his sympathy with the movement, which had been so ably expounded by both Mr. Makemson and the Director of Education. He deplored the fact that it was such a difficult task to get hold of suitable boys who were willing to become apprentices to the foundry trade, and thought this was in some measure due to the small wages paid during the term of apprenticeship.

A vote of thanks to Mr. Makemson for his eloquent address was proposed by MR. THORPE, which was seconded by MR. RIDSDALE, the local Secretary, to which MR. MAKEMSON responded in suitable terms.

The Resistance to Wear of Cast Iron in the Case of Sliding Friction.

The investigations on the resistance to wear of steel, cast iron, and non-ferrous metals hitherto made did not reveal any distinct relationship between this property and any other, especially

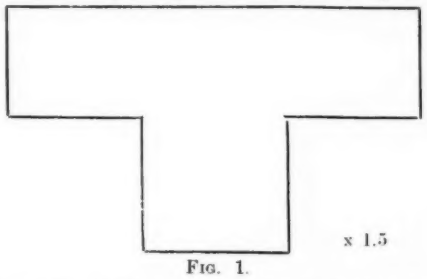


FIG. 1.

the Brinell hardness. Recently O. H. Lehmann[1] carried on experiments with cast iron to solve this problem. The test pieces were pressed against a rotating disc of 110 mm. dia. and 30 mm. wide which made 400 revs. per min. The experiments were carried on for an hour, then a stop of an hour took place in order that the disc and the test piece might cool, then the experiment was continued for an hour and so on. There were measured the loss of weight of the test piece after every run and the rise of temperature in the sample by means of a mercury thermometer. The Brinell hardness number was taken with a 10-mm. ball and a load of 1,000 kg. Additionally the samples were micrographically examined.

Preliminary experiments were carried on with plane samples, the dimensions of which were 30 × 20 × 18 mm. It was found that the resistance to wear increases when the hardness number increases, the difference in the loss of weight of the hardest sample and the softest one being 60 per cent. A high silicon-content seems to reduce the resistance to wear, in spite of a high hardness number. The samples with the higher total loss of weight show the slowest initial temperatures (which fluctuated between 80 and 100 deg. C.). The same result was found with respect to the temper colours in the neighbourhood of the sliding plane; but these colours (light yellow to dark blue) showed that in the sliding plane there existed a much higher temperature than indicated by the thermometer in the middle of the sample. The preliminary experiments also showed that in order to get correct results the whole machine must be fixed firmly so that vibrations may be avoided. In the main experiments another shape of the test piece was used as is seen in Fig. 1. This shape guaranteed that the pressure of 20 kg./2.5 cm.² remained constant during the experiment.

TABLE I.—*Abrasion Tests on Cast Iron.*

No. of Sample.	Brinell Hardness Number.	Composition.			Gr. in per cent. of T.C.	Loss of weight after		Total loss.
		T.C. per cent.	Gr. per cent.	Si per cent.		1 hr. Grams.	2 hrs. Grams.	
17C	123	3.01	2.48	2.65	82.4	3.55	0.27	3.82
15C	126	2.97	2.80	2.45	94.3	29.8	—	29.8
16C	129	2.97	2.80	2.45	94.3	36.1	—	36.1
20C	131	2.94	2.90	2.57	98.6	0.65	0.47	1.12
18C	135	3.01	2.48	2.66	82.4	0.34	0.20	0.54
21C	143	2.83	2.59	2.55	91.5	0.43	0.41	0.84
19C	144	2.94	2.9	2.57	98.6	0.50	0.30	0.80
26C	161	2.89	2.27	2.48	78.5	0.27	0.24	0.51
24C	164	2.96	2.56	2.36	86.5	0.28	0.24	0.52
28C	168	2.76	1.98	0.86	71.7	0.54	0.61	1.15
25C	171	2.90	2.28	2.49	78.6	0.21	0.21	0.42
27C	173	2.76	1.98	0.86	71.7	0.44	0.73	1.17
22C	174	2.81	2.58	2.55	92.0	0.27	0.36	0.63
23C	185	2.96	2.56	2.36	86.5	0.21	0.22	0.43

TABLE II.—*Abrasion in relation to Micro-constituents.*

Ferrite, per cent.	Pearlite per cent.	Sample No.	Total Loss, grams.
Nearly 100	—	15C, 16C	29.8, 36.1
,, 95	Nearly 3	17C	3.82
,, 75	,, 20	20C	1.12
,, 60	,, 30	19C, 21C	0.80, 0.84
,, 50	,, 40	22C	0.63
,, 25	,, 60	27C, 28C	1.15, 1.17
,, 10	,, 75	18C, 26C, 24C	0.54, 0.51, 0.52
,, 5	,, 90	25C, 23C	0.42, 0.43

Series I.—The disc consisted of rail steel. The Brinell hardness number of the samples were from 123 to 185. In Table I there are recorded the loss of weight, the Brinell hardness, and the chemical composition. It is to be seen that when the hardness number is below 130 the resistance to wear decreases rapidly, but as the experiments 17C, 18C, 22C, 27C and 28C show, it is not possible to establish a fixed relationship between these two properties. As to the influence of silicon the experiments show that it cannot be regarded as a factor controlling the resistance to wear as was concluded from the preliminary experiments. If this were the case the samples 27C and 28C would show the smallest loss of weight. On the other hand the loss of weight of the samples 18C and 24C should differ greatly, whereas those of the samples 19C and 20C would

TABLE III.—*Shows how Low Brinell Number influences Abrasion Resisting Properties.*

No. of Sample.	Brinell Hardness Number.	Composition.			Gr. in per cent. of T.C.	Loss of weight after		Total loss.
		T.C. per cent.	Gr. per cent.	Si. per cent.		1 hr. Grams.	2 hrs. Grams.	
15D	113	2.96	2.81	2.45	95.0	0.25	0.18	0.43
16D	117	2.96	2.81	2.45	95.0	0.19	0.22	0.41
30D	125	2.91	2.61	2.78	89.7	1.20	0.20	1.40
29D	127	2.93	2.62	2.78	89.5	2.98	0.35	3.33
33D	128	2.83	2.56	0.65	90.5	0.43	0.40	0.83
18D	129	3.01	2.50	2.63	83.0	0.16	0.17	0.33
19D	141	2.94	2.89	2.57	98.3	0.10	0.10	0.20
21D	142	2.84	2.60	2.57	91.5	0.11	0.18	0.29
17D	152	3.00	2.49	2.64	83.0	0.14	0.15	0.29
20D	154	2.94	2.89	2.57	98.3	0.18	0.13	0.31
28D	163	2.74	1.96	0.86	71.6	0.09	0.07	0.16
24D	164	2.95	2.55	2.37	86.4	0.08	0.06	0.14
27D	165	2.84	1.97	0.86	71.8	0.09	0.06	0.15
23D	169	—	2.55	2.37	86.4	0.10	0.06	0.16
26D	175	—	—	—	—	—	—	—

[1] Giessereizeitung, 1926, No. 21, 22, 23.

be equal. The same conclusion must be reached with respect to the graphite content (samples 17C and 18C). Therefore, the author thinks that one is not justified in accepting any relationship between the resistance to wear and the machinability as is done by Kessner[2], who found that the machinability as revealed by the drilling test increased when the contents of silicon and graphite increased. The micrographic examination revealed that a relationship can be established between the resistance to wear and the structure, as is seen from Table II. The ferrite is the most dangerous constituent; the pearlite, on the other hand, prevents wear. The phosphide eutectic also plays a prominent part: it is harder than the ferrite and parts of it are sometimes torn from out the material and act like emery. From this fact the heavy loss of weight of the samples 27C and 28C, which contained almost 60 per cent. of pearlite, can be explained when compared with the sample 20C containing only 20 per cent. of pearlite. The amount and the size of the graphite lamellæ do not play any part.

Series II.—The disc consisted of cast iron, the Brinell hardness number of which was 203. The test results are set out in Table III. Here, too, the resistance to wear greatly decreases when the hardness number is below 130. The chemical composition has no influence as is seen from the samples 23D, 26D, 28D. The surfaces of the samples 15D and 16D were vitreous which was caused by the abraded particles filling up the minute pores. The sample, as well as the disc, took part in the lubrication which hinders the wear. As it is seen from Table IV, these experiments, too, show that it is the structure which controls the resistance to wear.

Series III.—In these experiments the disc consisted of cast iron with a Brinell hardness number of 152. From the results which are recorded in Table V, the same conclusions can be drawn as from the Series I and II, with the exception that the loss of weight does not increase rapidly when the hardness number is below 130.

TABLE IV.—*Influence of Micro-Structure on Abrasive Resisting Properties.*

Ferrite. Per cent.	Pearlite. per cent.	Graphite.	Sample No.	Total loss.
About 100	—	Thick lamellæ	15D, 16D	0.43, 0.41
,, 95	About 3	Thin ,,	30D, 29D, 33D	1.40, 3.33, 0.83
,, 75	,, 20	Middle thick lamellæ	17D, 18D, 20D	0.29, 0.33, 0.31
,, 60	,, 30	Long thin ,,	19D, 21D, 22D	0.20, 0.29, 0.23
,, 50	,, 40	Middle thick ,,	23D, 24D	0.16, 0.14
,, 25	,, 60	,, ,, ,,	25D	0.18
,, 10	,, 75	,, ,, ,,	26D	0.16
,, 5	,, 90	,, ,, ,,	27D	0.15
,, 1	,, 95	,, ,, ,,	28D	0.16

TABLE V.

Sample No.	Brinell Hardness No.	Loss of weight after 1 hr. Grams.	Loss of weight after 2 hrs. Grams.	Total loss.	Ferrite. Per cent.	Pearlite. Per cent.
16E	105	0.25	0.17	0.42	About 100	—
15E	129	0.27	0.28	0.55	,, 100	—
18E	143	0.28	0.16	0.44	,, 95	About 3
21E	147	0.12	0.14	0.26	,, 60	,, 30
19E	149	0.18	0.17	0.35	,, 75	,, 20
23E	151	0.08	0.09	0.17	,, 5	,, 90
17E	157	0.25	0.14	0.39	,, 95	,, 3
28E	159	0.12	0.09	0.21	—	—
25E	167	0.09	0.08	0.17	,, 10	,, 75
26E	170	0.10	0.09	0.19	,, 25	,, 60
20E	171	0.20	0.16	0.36	,, 75	,, 20
24E	172	0.11	0.10	0.21	,, 50	,, 40
22E	175	0.17	0.16	0.33	,, 60	,, 30
27E	188	0.09	0.09	0.18	,, 5	,, 90

U.S. Steel Corporation.—The monthly report of the Corporation shows that the unfilled orders at the end of January amounted to 3,800,000 tons, as compared with 3,961,000 at the end of December and 4,883,000 tons at the end of January, 1926.

Krivoi-Rog Iron Ore.—During the first quarter (ended on December 31) of the current fiscal year the mines in the Krivoi-Rog produced 45,500,000 poods (731,200 British tons) of iron ore, representing 105 per cent. of the prescribed schedule. The German firm of Rawack & Grünfeld, of Charlottenburg, received during January two and a half times more iron ore than were contracted for.

[2] Speech at Konigsberg, 1915.

Pig-Iron and Rail Rates.

Statement by West Coast Furnace Owners' Association.

The West Coast Blast-Furnace Owners' Association has issued a statement calling attention to the serious effect on the pig-iron and allied industries on the West Coast of the decision of the railway companies to increase rates and charges as from February 1. They state: In considering the subject in all its aspects it should be emphasised that West Coast pig-iron is usually sold on terms which provide for delivery at consumers' works, while, on the other hand, raw materials are brought to the works on conditions which leave the manufacturers of pig-iron liable for the full carriage chargeable to their blast-furnaces. Consequently all pig-iron produced bears the railway carriage on raw material used, as well as the railway carriage charged for delivery of the finished product to consumers, and any general increase in railway rates must have a cumulative effect on cost of production.

Whereas under present circumstances the increased cost occasioned by such increase in rates has to be written off as irrecoverable from purchasers of pig-iron, if the railway companies had given from four to six months' notice provision could have been made in contracts for the additional liability. Alternatively the members urge that the railway rates in force at January 31 should be continued until the completion of contracts entered into before the notification of the increase in rates.

The members of the Association consider that, whatever may be the reason for such an arbitrary increase in rates, to impose such an increase at the present time on the pig-iron industry must ultimately result in loss to the railway companies themselves. Attention is also called to the very difficult situation that is continually arising by reason of shortage of railway wagons, which imposes further expense in the shape of handling costs.

Iron and Steel Output in January.

The National Federation of Iron and Steel Manufacturers report that the number of furnaces in operation at the end of January was 152, 75 having resumed operations during the month and one having been damped down. At the end of April, 1926, there were 147 furnaces in blast and 144 at the end of January, 1926.

Production of pig-iron in January amounted to 434,600 tons, compared with 98,000 tons in December, 539,100 tons in April and 533,500 tons in January, 1926. The January production included 142,500 tons of hematite, 154,100 tons of basic, 101,300 tons of foundry, and 17,400 tons of forge pig-iron.

The production of steel ingots and castings in January amounted to 730,700 tons compared with 319,300 tons in December, 661,000 tons in April and 640,400 tons in January, 1926.

German Engineers Discuss Electrical Furnace Practice.

An extraordinary meeting of the Electric Furnace Section of the German Society of Ironfounders (Giessereifachleute) was held on January 15 at the Charlottenburg Technical College, Berlin. About 300 were present from all parts of Germany and from practically every European country, including some of the leading specialists in electric furnace work.

After a short address of welcome by Dr. Dahl, the first President of the Society, in which he expressed pleasure at the large attendance, he referred to the work being done by the Electric Furnace Committee. The papers read at the meeting crystallised, to a certain extent, the Committee's work during the past few months.

Chemical Reactions in the Basic Electric Furnace.

The meeting opened with a Paper by Dr. F. von Kerpely on the above subject. Among the chief reactions in this type of furnace, said Dr. Kerpely, are those relating to oxidation. The oxidation of the silicon may be regarded as the most complete. Then follows manganese, with 50 to 55 per cent. oxidation. The lowest manganese content in normal melts may be taken as 0.1 per cent. If a higher percentage of manganese be desired, it is preferable to effect oxidation by high-manganese ores instead of the ordinary ore. To get the maximum dephosphorising effect, the melts should be effected at as low a temperature as convenient, the best temperature being about 1,370 deg. C., whereas the oxidation of the carbon begins at about 1,400 deg. C., and increases with rising temperature. The remarks that follow will deal briefly with the conditions governing complete and partial oxidation and its effect on the quality of the steel produced.

Although metallurgists appear to be pretty clear as regards the effect and reactions of the processes of deoxidation, opinions differ considerably concerning the amount and nature of the products of deoxidation suspended, in a state of fine division, in the melt. And it is those very particles that are mainly responsible for causes of failure in steel. Very effectual deoxidation would be possible by carbon, as the product of deoxidation in that case is a gas. But this is made difficult by the fact that metallic iron and iron oxides may exist at the same time, and their proportions may depend upon the temperature, the pressure, and the partial pressure of the carbon monoxide. Another way of attaining the result, viz., that in which oxidation occurs at the direct surface of contact between metal and slag, leads to the triple-slag method of working. Tests have been made with various kinds of alumina and bauxite in 3-ton and 5-ton Héroult furnaces, and, after removing first the oxide slag, then the carbide slag, the melt was treated for 20 to 25 minutes under an alumina slag. Where the percentage of Fe_2O_3 present was low, it was possible to produce a satisfactory steel. Due to the disturbing effect of the Fe_2O_3, the steel generally had a tendency to be lacking in deadness in the case of most of the aluminas used. The high percentage of magnesia is found to be very troublesome during melting operations, amounting sometimes to 26 per cent. in the slag, and originating from the furnace lining. No marked improvement was noticeable in the physical properties of the steel. Very good results, however, were obtained by treating electric furnace cast iron with an alumina slag. After 10 to 15 minutes' treatment, a metal exhibiting a very fine distribution of the graphite and with high physical qualities was obtained, so that there is every prospect of success in this particular direction.

Assuming that careful attention is paid in present-day melting operations to carrying on the process at a very high temperature during the period of deoxidation, if the melt is allowed to stand sufficiently long, and a suitable final deoxidant used, then the production of a satisfactory steel is ensured. As regards the gas percentage of the steel, the lack of "deadness" in the steel has no connection with nitrogen, being caused purely and simply by the formation of carbon monoxide. It is assumed that CO present in iron is not dissolved in the iron, but is present in the form of a nascent gas which decomposes with the formation of carbide. Oxidation of liquid iron is effected by these reaction gases, and the ferrous oxide compounds which occur and are unevenly distributed are then liquefied by the final deoxidants, which therefore explains the value of those latter.

The conditions that conduce to satisfactory melts in practice are: Not too high a bath temperature during the period of oxidation, very high bath temperatures during deoxidation under a highly effective slag capable of intense reaction, a fairly long period of standing, and cold casting.

The Economy of the Electric Furnace in the Foundry.

Dr. E. Kothny then read a Paper bearing the above title, in the course of which he said that the use of the electric furnace for foundry work rests in the advantages attending the use of electricity as a source of heat. In the present Paper economy calculations were discussed, which simply amount to a comparison of the first costs of the normal process of working and the electric furnace process.

For grey-iron foundry work, the electric furnace is preferable to the flame furnace owing to its recognised metallurgical advantages. The main advantage of the electric furnace compared with the cupola is in the high quality of the iron produced with the former. But so far as the standard quality iron is concerned the only advantage of the duplex process is that it enables melting to be carried out with an inferior type of charge. It can only compete with cupola grey cast iron where the increase in conversion cost is balanced by the saving in cost on the raw material. Examples of calculations are given in the Paper to show that the same cost for the cast material can only be reached, where either the price of electric energy is low or the yield can be increased by 2 per cent. above the yield of the cupola. On the other hand economy in the electric as compared with the cupola furnace—in which, because of modern developments only scrap and inferior iron are used as raw material—is only possible where the yield of the electric furnace can be increased as compared with the cupola. A normal cast iron produced in the cupola and, synthetically, in the electric furnace shows that, based on the same assumptions, synthetic electric furnace iron costs nearly 30 per cent. more. Only by reducing the price of current, securing a better yield, or with a great difference in the costs of the materials charged even with the same yield, can synthetic electric furnace cast-iron compete with cupola cast iron. Only when it comes to the production of high quality cast iron and intricate casting, will the duplex process and the synthetic process be able to take their place alongside the cupola or reverberatory furnace, owing to the excellent quality of the castings produced and the higher yield from the former processes.

It is in malleable foundries that the superiority of the electric furnace shows up as compared with the reverberatory, or cupola furnace or the Bessemer converter. Calculations have only been made comparing the cupola and the reverberatory furnaces. With a yield of 40 per cent. of sound castings, the costs of melting per ton of malleable iron made by the duplex process are higher than those of the cupola, but slightly lower than the cost of the reverberatory process, besides being superior to the latter. The use of the electric furnace only has an advantage over the cupola where current can be obtained fairly cheaply. A comparison of the electric furnace with the cupola and reverberatory furnace for the production of synthetic malleable iron shows that the electric process is only superior to the cupola process where either the price of energy is low, or a considerable increase in yield is possible. Compared with the air furnace, the electric furnace is only economical where

the cost of energy is low and the difference in the cost of raw material is at least 50s. One advantage of the electric furnace is that the malleablising process can be curtailed by keeping the carbon content lower, and this point must be credited to the electric process as compared with the cupola process. Economy of operation of the electric furnace in malleable iron foundries is, in this particular connection, anyhow, ensured.

Comparative calculations made in a steel foundry on 5-ton and 25-ton electric and Siemens furnaces with the same approximate output of 5 to 65 per cent., shows that, under the conditions assumed in the calculation, the electric furnace is 10 per cent. (in the case of the 5-ton furnace) and about 25 per cent (in the case of the 25-ton furnace) more expensive to run than the open-hearth furnace. The fact, however, that the author's own experience has shown that an increased yield of sound castings is possible, especially in the case of complex light castings, seems to confirm that the electric furnace is displacing the open-hearth furnace, particularly for the production of light castings. On the other hand, so far as 25-ton furnaces are concerned, they can only be expected to be economical where the cost of current as compared with the cost of fuel is very low.

Finally, the economy of the electric furnace for the casting of non-ferrous metals was discussed. In foundries working continuously and with a run of charges of the same composition, both the arc and the induction types of furnace are used. If, however, the composition varies frequently, or if melting is carried on for less than eight hours a day, the arc furnace must be regarded as the better type, the induction type not being suitable for intermittent work.

In foundries where work is continuous, and with a continuous production of similar composition, the induction furnace, with the same electrical losses, and current at 10 pfennigs (1.2d.) works out cheaper than the crucible type. In addition, the induction furnace has about 1.3 per cent. less losses. Compared with a non-crucible type furnace, the induction furnace gives the more satisfactory performance owing to the lower electrical losses: this comparison, of course, assuming the same prices for energy. On the other hand, the arc furnace is only more economical than the non-crucible type where the price of energy is lower.

For non-ferrous foundries working only intermittently, the arc furnace seems to be the better type. But it is only economical to run where it can be used for at least eight hours per melting day. In foundries of this type, the electric furnace will only be used to any appreciable extent where small electric furnaces that can be quickly put in and out of operation and having a low current consumption can be installed. The writer suggests that the development of the high-frequency type of furnace should be watched, because it is very likely the type that may prove to be more economical than all the other methods of melting.

The Coreless Type of Induction Furnace.

Dr. Fischer, Berlin, then presented a Paper bearing the above caption and first of all discussed, in electrical terms, the differences between low-frequency and coreless induction furnaces. Whereas the former, electrically considered, is nothing more nor less than an enclosed transformer with a short-circuited secondary winding, in the latter type there is an effective transmission of energy effected by increasing the rate of change or the frequency of the alternating magnetic field. It may be said to be an air transformer supplied by current of high-periodicity. The alternating magnetic field is formed by a cylindrical coil, inside of which is a solid cylinder —actually, the substance to be melted. The short circuited currents develop themselves, in the form of annular currents. The current density is greatest at the surface, decreasing rapidly inwards. Instead, therefore, of using a solid conductor or conductors, piping is used, as otherwise the core of the conductor would remain unused.

The theory of the furnace is based on Bessel formulæ, which govern the current density and the magnetic field. From theoretical considerations, it may be said that the energy absorbed by the substance to be melted, and converted into heat varies in direct proportion to the primary input. Of course, the specific coil load should not exceed 400 to 800 W/cm., on account of cooling. The higher the frequency, the quicker the heating, the frequency dropping as the square of the energy yield. The minimum frequency should be kept low where the conductivity or the diameter of the substance to be melted is great. As regards the actual design of the furnace, the height of the melting chamber should not exceed twice the diameter, so as not to impair the coupling between primary coil and bath. For this reason, it is advisable not to make the thickness of the walls too great. It has been found that, with magnesite lining, the best results as regards coupling is obtained with a wall-thickness of 80 mm. (3 in.) Since the ratio between effective yield and hypothetical yield is small the furnace has condensers inserted in the oscillating circuit which is tuned to the exciting frequency. Full loading of the high-frequency generator is ensured during the whole of the charge by means of the current resonance and voltage resonance wiring elaborated by the Lorenz works. The total thermal efficiency of a furnace plant connected up in this way will be about 75 per cent., and depends on the frequency used. The higher the frequency, the higher the theoretical inputs to be dealt with by the condenser. The transformer efficiency is from 70 to 82 per cent. compared with furnaces fitted with spark gap, where the efficiency was only 30 to 40 per cent. The larger the furnace, the lower can be the frequency. For a charge of a few hundred kilograms, frequencies of only 500 periods will suffice. For a 50-kilo. experimental furnace, an energy input of 1.5 kw. per kilo. of steel will be required. In a 100-kw. furnace, this energy required will drop to 1 kw., which makes the prospects of the future development of the large type of furnace (the type under discussion) very bright. Even now there are no further obstacles in the way of obtaining plants capable of handling charges of several hundred kilograms. Due to the pronounced movement of the molten material and the very intense reactions set up with the slag, it is possible that steel-making may be developed along fresh lines, as experiments at the Kaiser-Wilhelm Institute for Iron Research have already shown.

A demonstration melt with a coreless induction furnace followed the extremely interesting statements of the author of the paper.

Charges for Electrical Energy.

The last Paper to be read was one by Regierungs-Baumeister W. Schaefer, of Berlin, on charges for electrical energy.

The differences in negotiations connected with the price of electric power are mostly due to the fact that the definition "kw.-h" (kilowatt-hour) is always brought to the front, those dealing with the subject forgetting that this is a purely physical expression but one which is regarded at the same time as an economic unit which, in purchases of electric energy, represents a certain monetary value. But the decisive factors governing costs are generally not taken into account. In comparing electric-furnace operation with other plants, etc., using heat, such as open-hearth and cupola furnaces, it must be remembered that electrical energy is a conversion product subject, of course, to losses due to conversion, and prices of 2 pfennigs for current can only be possible in Germany to-day in certain localities and under very special conditions, such as continuous day and night work, depending on the arrangements of the power station. Even 3 pfennigs is only possible under very special circumstances in the present state of development of electrical power supply. On the other hand, by adopting rational methods of utilisation in furnace operation and by constantly supervising operation with a view to effecting economies, a great deal can be done. Since the period of use of power stations is small and the tariff of charges consequently high, special care must be given to selecting the size of furnace used. But bearing in mind the total costs of a power station divided by the number of units produced alone it is impossible to grant a low price for energy, because other social factors of cost must be taken into account, viz., transmission and distribution of the energy produced. The

better the power it utilised, therefore, the cheaper the price per unit, and it is on this point that the criticisms on the subject leave much to be desired. The period of use of the German electricity works is estimated at only 2,200 hours, as against 2,700 hours for the American stations. The principal cause of this is the electricity policy adopted by the various states and communes.

Demands are being made for a certain limitation of the maximum in electric furnaces. If, however, demands are pushed too far in that direction, it may be impossible to run such furnaces economically. Moreover, the maximum load is applied only at extremely short intervals. Attempts are being made to balance up the several groups of energy consumers, and, by allowing a slight addition for subsequent requirements, and by the exercise of a certain amount of good will, a means should be found for securing this compensation or balancing-up. A considerable drop in the price of current would thus become possible by such equalisation of loads.

It is obvious that the capital charges, due to the Government's "Gold Balance Order," must have an effect on the price of electrical energy, and the tariff increase in price, as compared with pre-war times, is estimated at 30 per cent. In a modern lignite colliery power station capable of generating 45,000 kw. and with a period of use of 4,000 hours, the prime cost works out at about 2.23 pfennigs where the fuel is burnt on a grate, but where the period of use is 5,000 hours and the boilers are fired wth pulverised coal, this figure drops to 1.91 pfennig. On the other hand, taking a period of use of 2,000 hours, the cost of current works out at 3.2 pfennigs per unit. These remarks clearly bring out the considerable bearing of the period of use on economy of production of electricity. If it should be possible in future to improve the efficiency of the plant by installing pulverising plants, the cost of current, according to Königsheim, could be reduced to 0.15 pfennig a unit, and such figures show that some caution should be observed when making long-term agreements for the supply of power.

As regards generating electricity at the works or foundries themselves, there would be no saving compared with obtaining power from a supply station where the period of use was 3,000 hours, and only in exceptional cases would it pay to lay down a generating plant.

Molybdenum in Steel.

The Research Department, Woolwich, has published, through the Stationery Office, R.D. Report No. 67 on "The Influence of Molybdenum on Medium-Carbon Steels containing Nickel and Chromium." According to the Summary and Conclusions, the thermal critical ranges, microstructure and mechanical properties of a number of nickel, chromium and nickel-chromium steels, containing up to about 1.4 per cent. molybdenum, have been investigated. The steels covered the following range of compositions:—

Type.	Carbon, per cent.	Nickel, per cent.	Chromium, per cent.	Molybdenum, per cent.
C-Mo ..	0.26 to 0.30	Nil	Nil	0 to 1.2
Ni-Mo ..	0.26 to 0.30	0 to 4.6	Nil	0 to 1.0
Cr-Mo ..	0.25 to 0.33	Nil	0 to 2.0	0 to 1.4
Ni-Cr-Mo	0.22 to 0.37	1.7 to 3.7	0.5 to 1.2	0 to 1.1

(1) Increasing molybdenum content slightly raises Ac_1 and lowers Ar_1, but its quantitative effect on the Ar_1 point varies considerably in different steels. In all the steels examined containing more than 1 per cent. of molybdenum and in steels containing upwards of 0.3 per cent. molybdenum with over 2 per cent. of nickel plus chromium, the Ar point was partially or entirely depressed to the Ar'' position at the rate of cooling employed in taking the curves (5 deg. C. per min. at 700 deg. C.). By means of the dilatometer it was found that in a steel containing carbon 0.29, nickel 2.47, chromium 0.64, and molybdenum 0.47 per cent. the Ar point, which normally occurred entirely at the Ar'' position (470 deg. C.), was completed in the Ar' position (650 deg. C.) when the rate of cooling was 0.5 deg. C. per min. Initial temperature is without effect on the position of the Ar'' point.

(2) Molybdenum has a more powerful effect than nickel or chromium in reducing liability to imperfect hardening when the rate of cooling is slow. It also reduces the softening effect of tempering. Although these changes in the characteristic properties of a steel due to the presence of molybdenum are progressive, with increase of molybdenum content the most marked effect is produced in nickel-chromium steels by the addition of not more than 0.5 per cent. molybdenum, the further advantage gained by adding more molybdenum being comparatively slight. The same property of complete hardening with moderate rates of cooling is revealed in the relative absence of mass effect in the nickel-chromium-molybdenum steels as compared with the nickel-chromium steels, shown by the uniformity of properties throughout the walls of large forgings after treatment. This property makes it more justifiable in the case of nickel-chromium-molybdenum steels than in most other alloy steels to make direct use of the results of treatment on a small scale to forecast properties of large forgings after treatment. It was found that results obtained by heat treatment of all the alloy steels containing molybdenum could be repeated with great regularity, showing that the steels were unaffected by slight departure from standard conditions of treatment.

(3) Mechanical tests, made after a comprehensive series of heat treatments, illustrate the general effect of molybdenum in improving elastic properties, yield point, elongation, and impact figure of certain types of steels. Molybdenum has a pronounced effect in reducing, or in some cases completely eliminating, the susceptibility of the steel to temper brittleness. No rate of slow cooling from the tempering temperature likely to be met with in practice has any effect in reducing the impact figure of steels of the types investigated containing more than 0.3 per cent. of molybdenum.

Nickel-chromium-molybdenum steels provide the best all-round combination of properties, but they are closely approached by certain nickel-molybdenum and chromium-molybdenum steels, each of which types shows some advantages and some disadvantages. For example, the chromium-molybdenum steels are distinguished by a high notched-bar impact figure, though the elastic limit and yield point are slightly lower than those of nickel-chromium-molybdenum steels of the same hardness. Nickel-molybdenum steels, on the other hand, show higher yield ratios with considerably lower impact figures than nickel-chromium-molybdenum steels. Moreover, they are more difficult to machine when the nickel content exceeds 3 per cent., which it must do to enable a tensile strength of 60 tons per sq. in. to be obtained, and tests made after different rates of cooling indicate that they are more susceptible to mass effect than the nickel-chromium-molybdenum steels. The results of tests given in the report enable a choice of the most promising compositions to be made for material intended to give a tensile strength of 50 to 60 tons per sq. in. The compositions of each type giving the best combination of mechanical properties in this range of hardness were as follows:—

Type.	Carbon, per cent.	Nickel, per cent.	Chromium, per cent.	Molybdenum, per cent.
Nickel-chromium-molybdenum *	0.3	2.6	0.6 to 1.1	0.6 to 0.4
Chromium-molybdenum †	0.3	—	1.0 to 1.5	1.0 to 0.5
Nickel-molybdenum ‡	0.3	2.7 to 4.0	—	0.6 to 0.4

* This range of composition gave very similar properties when tempered to the same hardness, the higher chromium being an advantage when a tensile strength of 60 tons or over is required.

† Slightly inferior in general properties to the nickel-chromium-molybdenum steel, but superior in notched-bar impact figure.

‡ Rather better in yield ratio than the nickel-chromium-molybdenum steel, but inferior in impact figure. When nickel exceeds 3 per cent. these steels show distinctly lower impact figures; also machining becomes difficult.

XUM

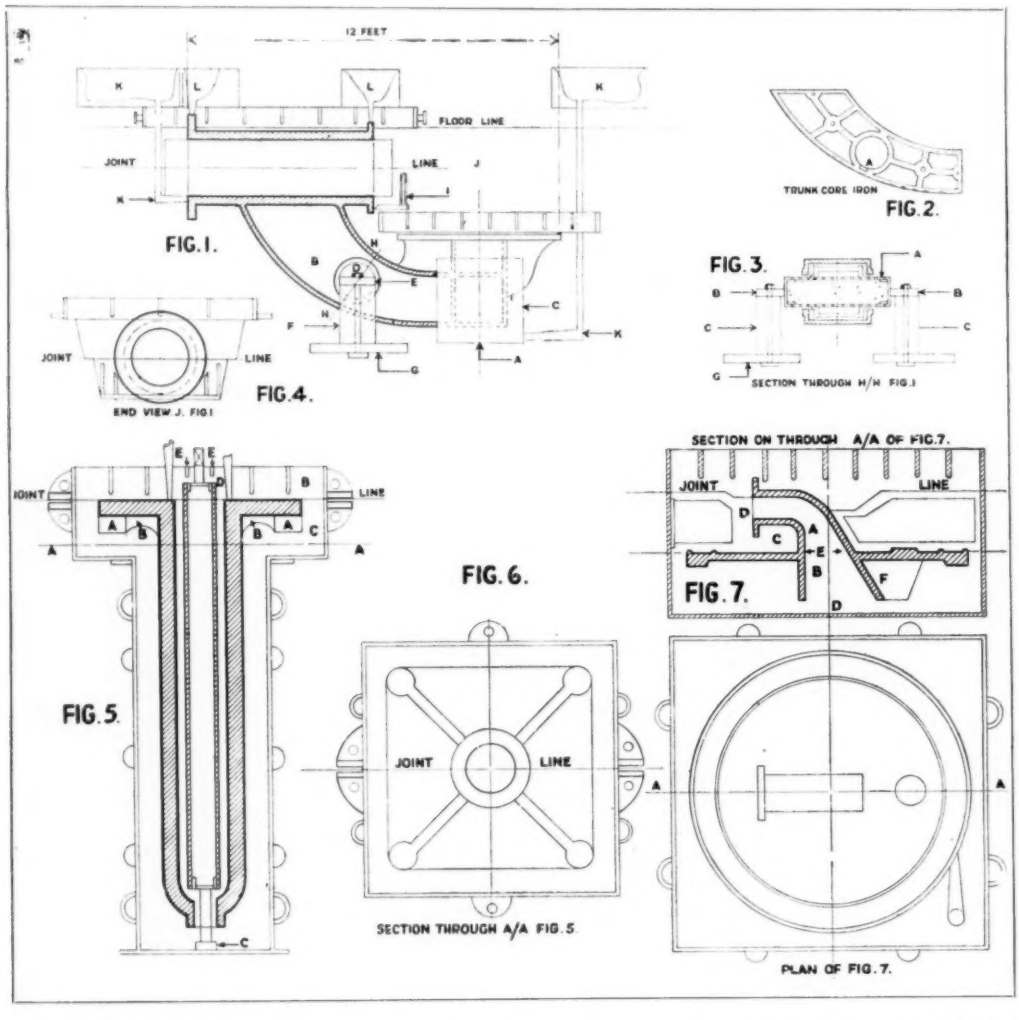
Odd Jobs.

By J. E. P.

Many foundries, running on a special line of work, are sometimes asked to take an odd job, just one off, and frequently are induced to take it, not knowing the exact amount of time the moulding and coremaking would involve, nor the amount of tackle which would be required to make it with, nor the risk of a waster.

In such cases it is generally discovered—when it is too late—that there is no hope of making a profit, as the price quoted was far too low, but there is every possibility of incurring a loss, even if the casting is a good one first time.

Such jobs ought not to come in the category of "jobbing work," they should be treated as *very special* and quoted for accordingly.



The ordinary jobbing foundry is the best to undertake and execute such jobs, providing, of course, that they are fairly well equipped with a variety of tackle; even so, it is not an easy matter to estimate successfully for such work.

It is not wise to place the whole responsibility of tendering for such jobs upon the estimating department. This department may have data upon which to base their figures, but without direct knowledge of all the operations involved for a particular piece of work, miscalculation and mistakes are inevitable.

The better way is, of course, for each job to be thoroughly worked out in detail by all departments concerned.

If pattern, skeleton, or strickles are required, then the pattern-shop manager should be the first to deal with the job, and he is wise who consults his foreman, and chargeman, and moulder.

Then the foundry manager should go into the question minutely, leaving nothing to chance. Cost of making tackle, cost of iron used for tackle, moulding, coremaking, both these latter items cover all time spent upon the job from the actual commencement of moulding and coremaking—not preparing tackle as is sometimes the case—until the mould is poured.

Having obtained all the costs of the details of the operation the result should then be dealt with by the estimating department.

Here they have all the movable charges and it should not be difficult for them to put on all the fixed charges. After the tender is ready it should be submitted to the foundry manager for final approval and endorsement.

Fig. 1 is a typical one-off job and could be moulded either in dry sand or loam. It weighed about 10 tons, and about 12 ft. long by 7 ft. deep, so that from the top of the runner cup or basin it would be about 9 ft. to the bottom of the casting.

The time involved in either methods of moulding would not differ much, but if moulded in loam many tons of tackle would have to be prepared, while if moulded in sand little or no new tackle would have to be made.

If moulded in loam it could have been made in a reasonable time and with a far greater amount

of safety, and a better chance of getting a first-class casting. On the other hand, to make it in sand, as Fig. 1 shows, much more skill would have to be expended upon it, the very best dry-sand moulders would have to be put to the moulding, and then the risk of having a faulty casting would be considerable.

It will readily be seen what an enormous pressure is put upon the mould at A, Fig. 1. To guard against this pressure, bars of pig-iron were rammed up in the mould round the foot at A, Fig. 1, and also the lower part of the trunk B, Fig. 1, keeping the bars back from the pattern about 10 in. The face of the foot C, Fig. 1, was covered by a cast-iron loam plate with about 1½ in. loam on it, acting as a drawback. This plate was very strong and carefully wedged to the mould from the back of the pit.

The trunk B, Fig. 1, was somewhat difficult, especially as the core had to be held in position by the only two openings, one at each side D, Fig. 1, also all the gas had to be taken off through these openings.

Fixing the Core.

The method adopted gave every satisfaction, two core irons were made, Fig. 2, one with prods or dabbers cast on, and one without. These two were then bolted together, forming a complete core iron, known in the craft as a bird-cage core iron. A cast-iron barrel A, Fig. 3, was made just small enough to pass easily through the hole in the core iron A, Fig. 2, then fastened tightly by cotter keys. The ends of the barrel, instead of having the usual round trunnions cast on, had a flat bearing at each end E, Fig. 1, and B, Fig. 3. These bearings rested upon blocks of cast iron F, Fig. 1, and C, Fig. 3, which were built upon cast-iron foundation plates G, Figs. 1 and 3. These plates had holes cast in the centres as had the blocks F, Fig. 1, and C, Fig. 3, and the bearings E, Fig. 1, and B, Fig. 3, so that when the core was placed in its position it could easily be bolted down and made quite secure, thus preventing any movement at the time of pouring.

Reference to Fig. 3 will clearly show section through H H, Fig. 1, it will also illustrate the method of fixing the core.

Two top part moulding boxes were used, one to cover the table, and one to cover the casing. On the top of the lower box part there was a loose part made, a kind of draw back, which allowed the lower box to be lifted off and handled the more expeditiously. It also allowed the mould to be the more easily finished and dried. This loose piece had to be built very strongly, as it had to carry the casing core. Fig. 4 shows view looking on end at J, Fig. 1; it also shows how the joints were made both for the top and bottom of the flange of the casing.

Two runners were used, K K, Fig. 1, and two risers at L L, Fig. 1. By having two runners the metal was distributed better, the mould was filled more quickly, and the metal during casting was hotter.

Closing the Mould.

The closing of this mould called for a large amount of skill and care. As will be seen, the lower box had to be packed and weighted perfectly, to resist the upward thrust of the metal as it filled the mould. Large heavy weights were placed upon this top. Then all was rammed up very soundly and strongly. The top box had not so much strain upon it, but that had to be attended to carefully. It is a good plan, in cases like this, to have a bottom runner as well as one higher up, as it supplies metal to the lower portion of the mould without the tearing effect, such as would occur if the top runner was used only. This mould occupied four moulders for about 16 days, and a very fine casting was made.

A Cylinder Job.

Fig. 5 shows a section of a casting in the moulding box with the core barrel in its position. This job was about 10 feet long, and weighed 3 tons. It was moulded horizontally in dry sand, and cast vertically.

The only moulding box in the foundry was a column box (top and bottom parts), but was not large enough to take the flange, so a supplementary box had to be made. A two-parted box was made, each part in halves, so in reality four parts were made. The bottom parts of this box were bolted to the column box, and the top parts were worked loose, as ordinary tops are, but for ramming up purposes these were fastened to the main box.

When all was rammed up and the top box lifted off, the pattern was withdrawn, then the half of the supplementary top box was removed; this allowed access to the ribs and bosses so that they could be the more readily finished, blacked and dried. Then one half of the supplementary top box was bolted to the bottom part of the column-box and the core placed in the mould and securely fixed, especially at the bottom C, Fig. 5, by a block of iron being placed in the box so that the end of the core barrel could rest upon it. The core barrel was firmly packed at the top D, Fig. 5, to prevent its floating, then the top part of the column box was lowered on and securely bolted and turned up on end; runners were placed at E, Fig. 5, but no risers; this job was very satisfactory. Fig. 6 will serve to show how the supplementary box was split.

An Awkward Pipe Job.

Fig. 7 shows a plate with a very awkward branch on the top side, A, Fig. 7, and a chute B on the underside.

The pattern came into the foundry built up in in one piece. The branch A was not blocked out for a core at C, but had to be taken out with a loose part like a drawback. The underside of the plate had to be machined all over, so that the plate had to be cast that side down. The only core prints were at D, and only one core box giving a core all in one piece; it will clearly be seen that as such, it could not be put into the mould, so it had to be made in two parts at E. The chute had to have a loose piece made at F. This had to be fixed in the mould, after the pattern was withdrawn and the bottom part of core B put in.

Altogether it was a very nasty job, and all this excessive work could easily have been avoided by having the branch pipe, A, cast separately and a flange on the bottom at E, then a facing piece on the plate and the branch bolted on afterwards.

Obituary.

THE DEATH HAS OCCURRED, in Glasgow, of Mr. Thomas B. Bingham. Mr. Bingham was well known in shipbuilding and engineering circles. For about 30 years he was connected with the firm of John G. Kincaid & Company, Limited, engineers, Greenock, and for eight years served as a director. Mr. Bingham, who retired from business two years ago, was 55 years of age.

MR. A. HANKINSON died on January 24 at Sydney, New South Wales, aged 68. He entered the service of Rd. Johnson, Clapham & Morris, Limited, in 1875, and after being in their Manchester office for about sixteen years, he went out to Australia for reasons of health. In the early part of 1893, while on a visit to England, he arranged to open an office in Melbourne for Rd. Johnson, Clapham & Morris, Limited, to sell galvanised sheets, etc., and owing to this venture turning out successful, offices were later opened in Sydney, Brisbane and Wellington (N.Z.). Mr. Hankinson was general manager of the Australian business of the company up to the time of his death, and in the course of his duties paid several visits to this country, being here as recently as last spring.

Personal.

SIR ARTHUR BALFOUR has been made a Commander of the Order of Danebrog by H.M. the King of Denmark.

SIR ROBERT MCLEAN, the agent of the Great Indian Peninsula Railway, is returning to this country in April to take up an appointment with Vickers, Limited.

MR. JAMES PIPER, the late hon. secretary of the Staffordshire Iron and Steel Institute, was presented, at the annual dinner last Saturday, with a silver coffee service as a token of appreciation for 33 years' service.

MR. JAMES RUSSELL, who forty-seven years ago was one of the founders of the Pather Iron & Steel Company, Limited, Wishaw, was last week the recipient of a presentation from the staff and employees on the occasion of his resigning the post of secretary. Mr. Russell, who has been an official for thirty-seven years, retains his seat on the board of directors. He resides at Sedan, Newmains, and is 85 years of age.

XUM

A Review of Foundry Conditions.

At the January monthly meeting of the Sheffield and District Section of the Institute of British Foundrymen, held in Sheffield, Mr. J. Emmott, a member of the Section, delivered an address entitled "A Review of the Foundry."

Speaking of the foundry generally, he said there was closely associated with it designers, pattern-makers, core-makers, chemists, furnacemen and, of course, the moulders who formed the largest proportion. During his Paper he would try to give a few details that touched each of these individually. The foundry itself he supposed everybody was familiar with, but a stranger when making his first visit found what appeared to be a dirty, noisy and gloomy place, which presented a succession of heaps and holes and a smoky, almost unbreathable atmosphere in which the moulder was nearly as black as the sand he used. It generally had poor lighting facilities, was badly ventilated, and was a decided trap for the unwary to walk across. It was often stated that anything would do for the foundry, but that statement must not be taken too literally, because even a foundry built on modern lines would soon become a dirty place through the very nature of the work performed in it. Where he worked his employer had a wash-house built, with hot and cold water laid, soap, towels and wash-bowls provided, but the men never took advantage of those facilities. However, he thought every foundry should have these provided, and every man should be made to use them, because if the men were able to go home clean and tidy it would be an inducement for a better type of youth to go into the foundry, whereas many youths at the present time looked upon it with disfavour.

The foreman moulder where Mr. Emmott worked often told him that moulders were a most unfortunate race of people, inasmuch as they got the blame for everybody's fault, but he noticed that if they could put the blame upon the pattern-maker or core-maker, or even the sand or metal, they quickly did so. Everybody would readily agree that the art of moulding was a highly-skilled craft, especially when it was concerned with non-repetition and artistic work. In fact, he sometimes wished he was a moulder doing those classes of work, for the moulder then created his objects to a certain extent from the raw materials. And from the delicate process and manual skill involved he might well be termed an artist in sand. That was specially brought home to him when he saw the large bronze statue of Sir William Wallace in the city of Aberdeen. Of course, that class of work was only for a favoured few, but whatever kind of foundry one worked at, whether at engineering, stove-grate, sanitary or domestic work it was up to the moulder to give his best, and by so doing raise the status of the foundry to the highest possible level. But the man who worked a machine or did nothing but repetition work soon became merely a mechanic, and lost all interest in his work, except the earning capacity. They could find quite a number of good moulders who, when asked the reason for doing a certain operation, replied that they did not know but if it were not done it would make a defective casting. That was not because they could not explain their thoughts, but it was due to a lack of technical knowledge. His listeners all knew the difficulty of producing good, sound copper castings, but with 1 per cent. of zinc the trouble was overcome. Some years ago his firm were making some boiler fittings in copper, and the moulder melted his own metal. During the process he put in a piece of yellow metal brass scrap, and when asked his reason for doing so he could only say that without that bit of scrap the castings would have all been porous. He had seen others do the same thing, so that things were often done through force of circumstances and because men had seen others use the same method. Mr. Emmott often thought the apprentice and boys should be told the "whys and wherefores" of certain peculiarities in founding, so that in later life it would be a great help to them to avoid many of the difficulties they had to contend with and were always running up against. There were a number of evening classes and a number of books on foundry practice in the libraries, so that the present-day moulder could not complain of the difficulty of improving his knowledge that would be instrumental in giving him a chance of getting to be perhaps a foundry manager. Many moulders could not see the reason why the pattern-maker should get such a position, but in the past the pattern-maker had attended technical classes and set himself out for that position, whilst the moulder had not troubled himself to do so, though probably that was due to force of circumstances. He might work a long distance from home, and to go home and wash and change after a hard day's work in the foundry was a consideration. Obviously washing facilities would be of benefit.

Moulding Machine Sales-Engineers.

The same thing applied to those who sold moulding machines. Mr. Emmott knew several who had been pattern-makers, who represented firms selling machines, and he had heard the remark, "What do they know about moulding?" but he contended that if they had to mount patterns on a plate for a machine and get good working results they would have to know a considerable amount about moulding or else they would soon be in trouble and have to make room for someone else who did. It must be remembered that a moulding machine would only do two things. First, ram the mould; second, extract the pattern without damaging the mould. The pattern-plate maker and foreman moulder were responsible for the rest. Quite a number of moulders did not seem to realise that the ultimate object of pattern-making was the production of sound and accurate castings. That statement was often lost sight of, but the pattern was an instrument guide which led up to effective castings, and one found the true value of the pattern by the results obtained, good or otherwise.

The art of founding and moulding was not one of the exact sciences, but it was largely composed of skill in which the human element played a large part. By far the most important part of founding was the formation of the moulds into which the metal was poured, and as it was impossible for the moulder to see inside the mould while the operation of pouring was in process the moulder's skill must be coupled up with a vivid imagination so that he could visualise how the metal would flow to make a perfectly sound casting.

Eliminating Defects.

He (the lecturer) had previously admitted that moulding was a highly skilled trade, but now he wanted to point out a few faults or defects in moulds and moulding that could, by a little more attention, be done away with. First of all faulty moulding, such as too hard or too soft ramming, was a source of much trouble. Another cause of inferior casting, in his opinion, was the piece-work system. In their haste to turn out as many moulds as possible, he had seen cores not thoroughly dry, cores that were cracked, and even cores with pieces broken off them, put into the mould. Moulds had been closed when the top part did not fit on properly, causing crushed and distorted castings. Again, others had not been properly closed, and fins and run-outs occurred. Also venting was not properly attended to. Those could be done on small repetition work on the chance of not being found out or when the foreman was doing something important that needed all his attention. They were due to carelessness, and ought to be obviated, for the moulder had quite enough to put up with with things that were beyond his control, such as sand, metal, poor tackle, bad designs, poor patterns, etc., without adding carelessness to them. It was often found that individual moulders in the same shop varied largely in their style of work, and the pattern that was suitable for one man was often unworkable for another. That especially was the case when patterns were sent to other foundries. He knew the present-day cry was for larger output, but the larger output tended to kill the real art of moulding, for the moulder was not allowed the time and labour

to bring out his best, and in many cases the work was scamped. Output consistent with good work ought to be aimed at. Another aggravating thing was the way some moulders mis-used delicate patterns by rapping and driving large spikes (file tangs) into them till they were sometimes mutilated beyond repair. They not only split and spoiled the pattern, but increased the weight of the casting, which made much difference to price, especially in non-ferrous metals, such as bronze, gunmetal, nickel, etc. It ought to be remembered it was the duty of the moulder to endeavour as far as possible to keep true to shape and size. Of course, the patternmaker was to blame in many cases. He was sure every patternmaker would be much better for spending twelve months in the foundry. He would then know the real reason for taper on patterns and where to apply it. He would see that core prints were adequately made for the job in hand, and why core boxes were made so that the cores fitted accurately into proper position. Short core-prints were always a source of trouble and worry. The patternmaker should indicate clearly the joining of the pattern for the purpose of moulding, and also see that all loose pieces were not screwed up tight, for the moulder had only a small screw-driver to work with, so that he sometimes found it nearly impossible to unfasten loose pieces without damaging the mould. The lecturer thought most of his hearers had at some time or other come across patterns and core boxes far more elaborate than useful, and undoubtedly a short spell in the foundry would vastly improve a patternmaker's knowledge of patterns and their designs. He expected that most foundry managers objected to large core prints as a waste of valuable time in the mould, but "better safe than sorry" was a good motto in that respect, and in a good many instances the extra length of print could be utilised and used with economy and advantage, as he showed in a few sketches. The same regime applied to draughtsmen. They ought to spend a period in the pattern-shop and foundry. One came across most intricate and ingenious designs, which turned out very often unworkable, and had to be modified to be a success. The draughtsman's practice in the shops would make him conversant with the problems that cropped up, so that he would realise the necessity of simplifying his designs, but at the same time produce sound castings.

The Influence of the Chemist.

He did not know whether he ought to say the next few remarks, but they concerned a point one must often notice, both in lectures and in THE FOUNDRY TRADE JOURNAL. When he heard a chemist lecture he generally had the impression from his remarks that chemists were the most important members of the foundry trade, and one must agree that they were important, for they did improve the products of the foundry, but they did not produce castings. If they looked back to before chemists' time, they saw castings hundreds of years old still in a fine state of preservation. They were really good castings. There was in Knaresborough Castle a bushel measure dated 1670, and he doubted if it could be improved at the present time; again, there were the ancient bells of the cathedrals. Of course it might be said that they did not count for much now. But there were other things of more useful service. Take the picturesque bridge over the Tyne which was nearly 100 years old and composed of cast iron. It was built in a very exposed position, and had a vast amount of traffic continually passing over it, both railway and vehicular. Now, the thought impressed itself upon one, that the foundry without the chemist was capable of producing castings, but a foundry without the moulders would soon be putting the shutters up. One would naturally imagine that such an important industry as the foundry would make a complete study of conditions which would tend to increase production so far as actual moulding equipment was concerned. Recent years had seen vast improvements, and in large modern foundries it was no longer necessary for a boy to riddle sand or for a moulder to ram sand into his boxes. The art of the founder and the science of the metallurgist made a splendid combination for the improvement of the foundry, but the introduction of the metallurgist did not put an end to foundry troubles. Operations were now performed through the agency of compressed air or hydraulic power. Those, and many other improvements, were desirable, since they promoted efficiency and increased production whilst having less physical exertion on the moulder's part. Despite the introduction of machinery, he thought there would always be room in the foundry for skill and brains.

Good Illumination Essential.

It would be very hard to imagine any industry where good illumination was more essential than in the foundry. The nature of the work performed had a great tendency to keep daylight outside the foundry walls. Smoke, steam, dust, etc., floating about in the atmosphere covered the windows with a thick coat of grime, so that even in broad daylight the sun could not penetrate through them, and the inside always had a gloomy appearance. Yet good artificial light was one of the best assistants the moulder could have. The effect of good light upon the moulder was increased production, and his work could be done in a better manner. The mould should not be in a mass of shadows making it difficult for the moulder accurately to locate the cores in their proper places. The light should be in such a position that cores could be inserted to any part of the mould without risk of injury to the mould, thereby avoiding poor castings through patching up this broken mould. Good light would also help to eliminate many of the accidents that frequently occurred. It should be emphasised that a foundry could not be expected to develop the best type of men if men were worked under bad conditions. He supposed most of them remembered the old oil lamps and tallow candles flickering about during the dark winter days, and what a miserable atmosphere it was to work in. He thought, until recently, these lamps were things of the past, but only a few months ago he saw an advertisement for them. Aluminium founders needed as natural light as it was possible to get, because in a bad light one was given the impression of the metal being very hot yet at the same time it was on the point of solidifying. In conclusion he thought the patternmaker and the moulder ought to regard each other as colleagues rather than rivals, so they could gain a thorough knowledge of each other's trade in these two important branches of the foundry industry.

DISCUSSION.

MR. F. A. MELMOTH said he did not quite see how the title of the paper applied. To him the paper had been a homely little statement of foundry facts from the point of view of the patternmaker. With quite a lot of the points everybody would be in sympathy, but there seemed to be a tendency by Mr. Emmott to deal with the production of castings as an art and not entirely as a matter of commerce. They realised that although it might be an art and in their spare moments they teased themselves into believing that the art was the great thing, they had to make castings and sell them. Mr. Emmott had also referred to piece-work, suggesting that it was the cause of much trouble, but he must have been very unfortunate with foundry foremen. Piece-work could only be successful if the foreman was of the efficient type. It certainly called for additional supervision, but it was not fair to blame piece-work for all the carelessness which ought to be stopped. Without piece-work, he doubted whether there would be any opportunity of selling castings at all. In regard to the relative position of patternmakers, moulders and metallurgists, Mr. Melmoth thought Mr. Emmott had slightly misjudged the metallurgists. Most metallurgists he (Mr. Melmoth) had met were only too willing to learn as much as possible about the really practical side of the foundry, and had only hoped that any knowledge they possessed would be useful to the foundry and would help to solve a few of the difficulties the moulder had not succeeded in solving himself. As a rule, their only desire was to be helpful. It was granted that the moulder had managed without the metallurgist in the past, but under present-day conditions, when demands made upon all metals had increased enormously and designs had altered, so that metallurgists had to find methods

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of making better metals, it was possible to appreciate the real value of metallurgists in the foundry. With all other points in the paper, such as the desirability of good lighting and washing facilities, he agreed entirely.

Mr. J. T. Goodwin, Vice-President of the Institute, said that Mr. Emmott was evidently in close touch with the foundry, and they all recognised the weak spots he had mentioned. He agreed with Mr. Melmouth's remarks in regard to the metallurgists. It was the question of the commercial proposition where they had to have lighter castings to cut down the price, and in that connection the metallurgist was certainly giving help. After referring to sketches shown by the lecturer, Mr. Goodwin commented on the fact that the lecturer had not referred to the methods of pouring. They might have been usefully referred to, because they were very interesting.

Replying to the previous discussion, Mr. Emmott said that if a foreman had a score of youths and others under him on piece-work, he had to be a "super-man" adequately to control them.

Mr. J. R. Hyde said there seemed to be nothing new under the sun, when it was ventilated at a meeting of the Institute of British Foundrymen. Some fifteen years ago they had one or two little things which they thought were trade secrets, but they found out that they were the subjects of lectures and that everybody knew those special things they were keeping secret in Sheffield. There was a great advantage in the exchange of ideas and knowledge. Fifteen years ago there were no metallurgists in the foundry—they could not afford such luxuries. Sixty years ago most of the pig-iron bought was cold-blast iron or just warm-blast iron, and that gave a superior product to what was bought to-day. They had to bring in the metallurgists to utilise a hot-blast iron so as to give them the same results as a cold-blast iron, but, of course, with a cheaper price. If they wanted a really good casting and they put in a 50 per cent. mixture of cold-blast iron they got it every time. "Don't discharge all the metallurgists," added Mr. Hyde. (Laughter.) A cold-blast iron was subject to various troubles which were not met with in hot-blast iron—it would not run up into the sharp corners as it ought to do. Consequently they blamed the moulder and the pattern maker, etc. An exchange of knowledge, such as was obtained by hearing such papers as the one which had just been read, and the holding of such meetings, was distinctly useful. The moulder—whether working piece-work or day-work—saw the same job so often that he did not notice the slight differences in the routine, and if they brought a man out of the laboratory or from the pattern shop he might see the slight variation in the procedure, and that slight variation made a real difference. He had heard—particularly during the war—of one foundry making a success of one job and another not being able to do so, a small matter, apparently quite trivial, making all the difference between failure and success.

Mr. H. Bradley thanked Mr. Emmott for his interesting paper and sketches. He thought that when they carefully studied the lecture there was a good deal of little differences in it, that arose from the pattern maker's and the moulder's varying viewpoints, and also that of the moulder and the metallurgist. To have everything successful they had to obtain those three men working together as one. When a moulder blamed a pattern, he (Mr. Bradley) always said that if the pattern was incorrect then the moulder should not have worked from it, and the same applied to the core maker.

The Chairman (Mr. G. Edginton), referring to cylindrical castings, said they very often had too short branches. They ought to have 3 in. of branch on a 24-in. diameter job. It would be preferable if some pattern makers would see that it was at least about 9 in.

Mr. T. Brown, referring to Mr. Bradley's insistence on returning every imperfect pattern, reminded his audience that founders had received patterns from different places and refused to work from them, but when they sent them back they were told that their failure could not be understood because a large number of moulds had been made off the same patterns before. If they had to send them back it was likely they would lose the order.

Mr. W. Barker said that the reason castings were made heavier in the old days was because it was believed that the more material there was used the stronger the casting was. If there had been metallurgists they would have had far lighter metal.

A vote of thanks to the lecturer was proposed by Commander L. Jackson and seconded by Mr. Macdonald.

Staffordshire Iron and Steel Institute.

The annual dinner of the Staffordshire Iron and Steel Institute was held on February 12, at Dudley, a large number of members attending. Supporting the President (Mr. D. H. Ingall, D.Sc.) were Viscount Ednam, Councillor W. Bradford (Mayor of Dudley), and Councillor David Lewis (Bilston).

Councillor Lewis, proposing the toast of the "Iron, Steel and Coal Trades," said that it was the duty of such an Institute as theirs to bring together those who had to face the very severe problems of the present to consider how best to adapt themselves to varying circumstances, realising that what was good enough a few years ago would not pass muster to-day. That week he had returned from a visit to Germany, and had had there an opportunity of seeing quite a considerable number of works, and of seeing some of the problems presented by the new situation, as they saw it in Europe to-day. Germany was now facing the situation with seriousness and courage, and he had no doubt that they were very formidable competitors, though manufacturers in this country would now be able to meet them on more equal terms than some time ago, because conditions in Germany had changed, and were very different from those prevailing in the neighbouring country of Belgium. From there, Councillor Lewis did not see how they were going to meet competition, with the franc at 172 to the £. When they had labourers working for something like 20 francs per day (2s. in terms of English money), they would realise that there was an example of conditions which were very serious not only for the foundry trade, in which he particularly was concerned, but for every section of the industry.

There was undoubtedly in Germany, especially in the case of cast-iron, a very marked effort to improve the quality of their product. At least three processes were being worked at the present time by which cast-iron was being produced with a tensile strength nearly double that which had been regarded as Admiralty standard of this country, and there was no doubt a higher standard would be required by users in this country, so that it would be necessary for those firms who were anxious to meet the necessities of the time that they should adapt themselves for new conditions as they arose.

Lord Ednam, responding, said it was essential for the coal industry, if it was to survive, that there should be an abundant supply of cheap fuel. Without that, the other industries could not live either. As the result of the local settlements which had been signed all over the country, there was a much brighter future for the industry. The men, he thought, had at last come to realise that the coal industry could not survive unless they had adequate production, and that it was impossible to obtain adequate economic production under the Seven Hours' Act. If they could get a sufficient output from their pits they could afford to pay the men as good and even better wages than they were getting before the strike. They, undoubtedly, had many difficulties ahead yet, and they had got to concentrate very hard on scientific research and development.

In regard to the iron and steel industries there again, Lord Ednam thought, there were signs of a brighter future than they had had during the past five years. It was difficult to tell exactly what the situation was at the present moment, while trade was in such an abnormal state, but he thought that when prices had ceased to fluctuate and trade became more normal, they would see before them prospects of better times. But they had to face modern conditions. They were never going to have the prices either for coal or steel, which reigned in past years. They had got to produce their materials cheaper and cheaper, and they could not do that unless they got together. He did not say that the time had come when they should amalgamate to the same extent as in some other countries, but the day was dawning for closer co-operation.

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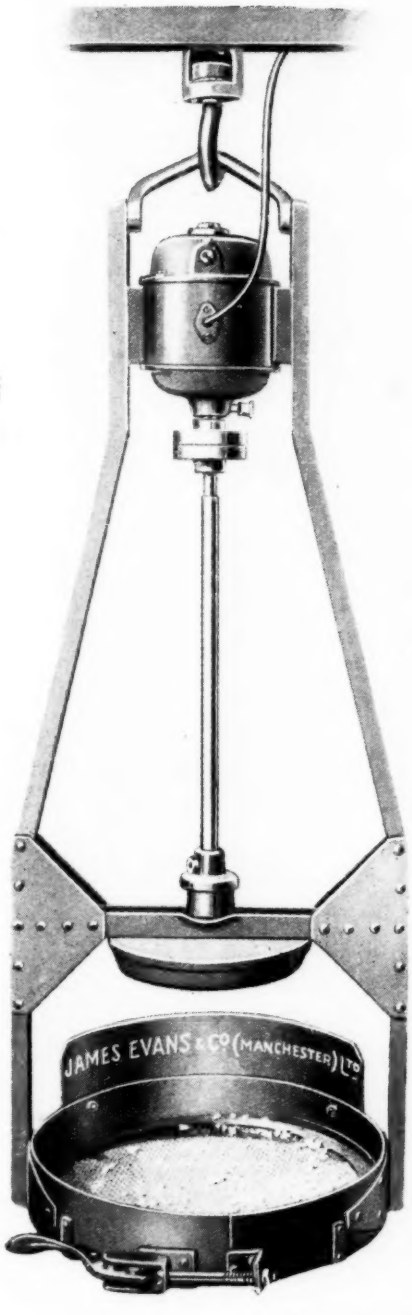

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BRITANNIA WORKS,

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Trade Talk.

THE SCOTTISH IRON AND STEEL COMPANY, LIMITED, have removed from 105, St. Vincent Street, Glasgow, to 53, Bothwell Street, Glasgow.

RANSOMES AND RAPIER, LIMITED, Ipswich, have removed their Manchester office to 38, Deansgate, Manchester, under the management of Mr. C. C. Richards.

THE CHANGE of name of Vickers-Petters, Limited, to Petters (Ipswich), Limited, has now been officially sanctioned, and use of the new name is being made forthwith.

PALMERS SHIPBUILDING AND IRON COMPANY, LIMITED, Jarrow-on-Tyne, have booked their fourth oil-tanker order within a fortnight, the latest vessel being a 10,000-tons motor-ship for the British Tanker Company.

BEYER, PEACOCK & COMPANY, LIMITED, have an order for nine 4-6-0 superheated locomotives for the Ceylon Government Railways, to whom the Sentinel Wagon Works, Limited, of Shrewsbury, are supplying two Sentinel-Cammell steam railway coaches.

W. GRAY & COMPANY, LIMITED, of West Hartlepool and Sunderland, are about to reopen their yard at Sunderland, where they intend to construct three vessels of 8,000 tons each. Each vessel will be about 400 ft. long, and they are all for British owners.

WHAT IS REGARDED as a record output from one mill is claimed by the Clydebridge Steel Works of David Colville & Sons, Limited, Cambuslang. Recently this firm turned out in one week 5,600 tons of steel, the output being accomplished by the night and day staff.

SHIPBUILDING PROSPECTS on the Tyne for the present year have been further improved by the placing of additional orders, and when more adequate supplies of materials are available within a few weeks, the larger yards on the river will enter upon several months' full employment.

THE CLYDE SHIPBUILDING for January shows that only one sea-going vessel, the "Reynolds," of 5,209 tons, built by Robert Duncan & Company, Port Glasgow, was launched. In the corresponding month of last year twelve vessels of 16,922 tons were put into the water.

PLANS FOR THE North-East Coast Exhibition (May to October), 1928, are rapidly maturing. Nearly half the amount of £150,000 (£73,001 7s.) has already been promised, and the organiser, Mr. C. P. Hainsworth, emphasises the fact that there is little likelihood of the sums guaranteed being called upon.

ELECTRIC FANS, LIMITED, 53-54, Royal Mint Street, London, E.C.1, have acquired the business of Manda Motors, Limited. The commercial and general management of the company will be in the hands of Mr. V. Delebecque, who becomes a director, while the works management will be under the control of Mr. C. W. L. Pearce, late works manager of Dynamo Repairs, Limited.

THE CAMBRIAN WAGON COMPANY, LIMITED, East Moors Road, Cardiff, have obtained the sole rights from the Easton Car and Construction Company, to manufacture Easton design equipment as made by them at Easton, Pennsylvania, U.S.A. The Easton Car and Construction Company are builders of Easton cars or wagons of special designs in steel, especially suitable for quarry work. The company have just manufactured a Phœnix type Easton car (Patent pending), which can be seen in use at a North Wales Quarry.

IN CONNECTION with the working arrangement between Gwynnes Engineering Company, Limited, and William Foster & Company, Limited, of Lincoln, mentioned in our last issue, a new company has been registered under the style of Gwynnes Pumps, Limited, to carry on the business. The new company takes possession of the works as from February 1, and all work in progress will continue to be dealt with for the present at the Hammersmith Iron Works, although it has been decided ultimately to transfer the manufacturing side to Lincoln. The directors of Gwynnes Pumps, Limited, will be Sir William Tritton (chairman), Mr. Neville G. Gwynne (managing director), and Mr. Charles Pennell.

THE LARGE MILL of the Appleby Iron Company, Limited, started up this week, and is producing mild steel plates ¼ in. to 1½ in. thick. These plates, we understand, are automatically hot mangled after rolling. The small mill is not yet operating, but it is anticipated will shortly be in a position to commence production of plates down to ¼ in. thick. The new works are situate on land adjacent to that of the Frodingham Iron and Steel Company, Limited, and it is intended to work the plant as a department of the Frodingham Iron and Steel Company, Limited, with the same technical and commercial staffs. Both these concerns are units of the United Steel Companies, Limited, the London office of which is St. Stephen's House, Victoria Embankment, S.W.1.

Contracts Open.

Alnwick, February 28.—(1) 180 yards of 2-in. cast-iron socket pipes; and (2) 168 yards of 1½-in. cast-iron pipes, for the Alnwick Rural District Council. The Clerk, Fenkle Street, Alnwick.

Ashborne, March 21.—Complete installation of a high-class pumping plant in duplicate, for the Ashborne Urban District Council. Mr. R. Williams, clerk, Council Offices, Ashborne, Derbyshire. (Fee £5, returnable.)

Bakewell, February 26.—58 tons of 4-in. and 3-in. cast-iron gas and water mains, for the Urban District Council. Mr. T. W. Baker, surveyor, Bakewell.

Bedford.—(1) E.h.t., h.t. and l.t. underground cables during year ending March 31, 1928, for the electricity department. The Borough Electrical Engineer, Prebend Street, Bedford. (Extra copies 5s. each.)

Brighton, March 14. — Triple-expansion pumping engine, well and force pumps, Lancashire boilers, superheaters, etc., for the Corporation. Mr. A. B. Cathcart, waterworks engineer, 12, Bond Street, Brighton. (Fee £5 5s., returnable.)

Buxton, February 26.—(6) Castings (street ironwork) for period ending December 31, 1927, for the Town Council. Mr. F. Langley, borough engineer, Town Hall, Buxton.

Cairo, February 28.—Machine tools and textile machinery, for the Egyptian Ministry of Education. The Department of Overseas Trade, 35, Old Queen Street, London, S.W.1. (Ref. A.X. 4181.)

Guildford, February 28.—(8) Iron castings during year ending March 31, 1928, for the Town Council. Mr. J. W. Hipwood, borough surveyor, Tuns Gate, Guildford.

Drogheda, February 28.—(a) Spun pipes, all lead jointed; (b) continental pipes; and (c) spun pipes, 80 per cent. T. and B. and 20 per cent. S. and S., for the Corporation Mr. P. H. McCarthy, the engineer, 26, Lower Leeson Street, Dublin. (Fee £5 5s., returnable.)

Grenoside, near Sheffield, March 23.—(8) Iron castings during year ending March 31, 1928, for the Wortley Rural District Council. Mr. F. Thurlby, engineer and surveyor, Grenoside, near Sheffield.

Grimsby, February 26.—Specification No. 227, cast-iron and steel pipework, valves, etc., for the Corporation. Mr. W. A. Vignoles, borough electrical engineer, Corporation Electricity Works, Grimsby.

Johannesburg, March 3.- Overhead line material, including pole brackets, Crosby clips, etc., for the South African Railways and Harbours. The Department of Overseas Trade, 35, Old Queen Street, London, S.W.1. (Ref. B.X. 3224.)

Leeds, February 22.—Wrought-iron fencing, for the Corporation. Mr. W. T. Lancashire, city engineer, Municipal Buildings, Leeds.

Leeds, March 1.—(8) Cast-iron nameplates during year ending March 31, 1928, for the Highways Committee. Mr. E. W. Cockerlyne, highways engineer, 1, Swinegate, Leeds.

London, W.C.1, March 1.—Iron castings for 12 months ending March 31, 1928, for the Borough Council. Mr. J. E. Parr, borough surveyor, Town Hall, High Holborn, W.C.1.

Nottingham, March 3. — (h) Iron castings, iron gullies, etc., from April 1 to March 31, 1928, for the Works and Ways Committee. Mr. T. Wallis Gordon, city engineer and surveyor, Guildhall, Nottingham. (Fee 5s. each, returnable.)

Pontypridd, February 26.—Steel mains and specials, for the Gas Department of the Pontypridd Urban District Council. Mr. D. Muir, engineer and manager, Gasworks, Treforest, Pontypridd.

Rathmines, March 5.—Iron castings for year ending March 31, 1928, for the Rathmines and Rathgar Urban District Council. The Surveyor's Office, Rathmines.

Southend-on-Sea, February 26.—Iron castings during 12 months from April 1, 1927, to March 31, 1928, for the Corporation. Mr. R. H. Dyer, borough engineer, Southend-on-Sea.

Stoke-on-Trent, March 1.—(1) Steel files; (6) malleable iron and steel bars, plates, etc.; (10) bolts and nuts, rivets, etc.; (12) brass stop cocks and couplers; and (13) wrought-iron tubes and fittings, for the Council, for 12 months commencing April 1, 1927 Mr. A. MacKay, the chief gas engineer, Gas Works, Etruria, Stoke-on-Trent.

Stratford-upon-Avon, February 25.—Cast-iron pipes and specials, for the Corporation. Mr. F. W. Jones, borough water engineer, Municipal Offices, Stratford-upon-Avon.

Yarmouth, I. of W., March 2.—Two miles of 5-in. to 8-in. diameter cast-iron water mains, and about 560 yards of 3-in. main, together with valves, hydrants, etc., for the I. of W. Rural District Council. Mr. J. H. Blizard, Castle Lane, Southampton. (Fee £3 3s., returnable.)

No. of Alloy	Specific Gravity.	Melting Point °C.	Test Specimen.	Average Tensile strength Tons—sq. in.	Average Elastic limit Tons—sq. in.	Per cent. Elongation on 2 in.	Remarks.
4	2.75	643	Sand cast	6.5	4.5	4	A light copper alloy which is an admirable substitute for soft brass. Is very ductile, and has a high shock resistance.
			Chill cast	9.5	5.0	8–11	
6	2.98	615	Sand cast	13.0	8.5	4	A copper-zinc alloy which is very strong, easily cast and suitable for general purposes. It has excellent machining qualities.
			Chill cast	13.5	9.0	5	
6a	3.12	600	Sand cast	16.0	12.0	2	Stronger, but heavier than No. 6. Will take a very high polish.
			Chill cast	17.5	11.0	5	
12	2.83	629	Sand cast	7.0	6.0	2	A very reliable non-porous copper alloy. Is largely used for die-castings, as well as for sand castings.
			Chill cast	10.5	7.0	4	
38	2.88	622	Sand cast	9.5	6.0	5	
			Chill cast	11.5	5.5		
50b	2.72	645	Chill cast	9.0	6.5	13	A light nickel alloy which makes hard ductile castings, suitable for mathematical instruments, etc

The above figures are average test results made on specimens cast to 1 in. diameter and machined at the centre to 0.564 in. diameter.

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IRON AND STEEL MARKETS.

Pig-Iron.

MIDDLESBROUGH.—The Cleveland pig-iron trade would seem to be as far as ever from a return to normal. The steelworks are still absorbing the great bulk of the output, and they will probably continue to do so for some months to come. Hence, although deliveries against old contracts are improving, the position remains very difficult. On the other hand, there is no great pressure for pig-iron from the foundries, most of which are carrying on under very favourable pre-strike contracts, and there is, therefore, no particular inducement to negotiate fresh business. They can well afford to wait, especially as deliveries are doubtful, and there may be some chance of making new contracts on easier terms.

There is not enough hematite to go round, and the price of East Coast mixed numbers is pretty firmly held at 90s. per ton. Continental hematite can be brought into the Tees at a c.i.f. price of about 86s. per ton, but very little has been done in this direction, owing, no doubt, to the fact that the foreign material is not up to the quality of Cleveland hematite. On the other hand, moderate lots of the latter, consisting mainly of special analyses, are being sold abroad. In the North-West of England the orders that makers of hematite pig-iron hold give the assurance of the maintenance of production until May; but the business now at command mainly concerns prompt delivery, users still being averse from entering into commitments beyond the penultimate month of the first half of the year. Smelters see no immediate prospect of an expansion of the volume of forward business which they are anxious to obtain, the high railway rates, uncertainty regarding the Chancellor of the Exchequer's taxation proposals, and the trouble in the Far East all being regarded as factors that retard the growth of confidence.

LANCASHIRE.—There have been one or two sellers of pig-iron on the Lancashire market this week who have experienced some improvement in the amount of business done, but they stress the fact that it has only been extremely slight. The attitude of users generally seems to be that they are prepared to conduct their buying operations as they have done since a resumption was made at the blast furnaces. Most of the transactions that are reported now are of a hand-to-mouth nature, with little, if any, disposition so far as users are concerned to enter into forward contracts.

THE MIDLANDS.—There has been no alteration in the prices of the various brands of foundry pig-iron, and it appears likely that the present figures will hold for a week or two until the furnaces are back to normal working. At the present moment Northamptonshire No. 3 is quoted at 80s. at the furnaces, whilst Derbyshire and Staffordshire No. 3 is named at 85s. at furnaces. There is a stringency in No. 1 iron.

SCOTLAND.—Listlessness continues the feature of the Scotch pig-iron market, and prices are a shade easier at from 90s. to 91s. for No. 3 foundry, f.o.t. furnaces. Prices are not coming down as quickly as traders expected, and this is no doubt one reason for the scarcity of new business. At the moment there are no signs of an immediate improvement in demand, and forward business is not being discussed.

Scrap.

In Cleveland heavy cast-iron scrap is realising 78s. 6d. to 79s., and there is an active demand for ordinary qualities at 75s. per ton. The demand for heavy cast-iron scrap in large pieces and furnace sizes in Wales has weakened, and is easier at 66s. 6d. to 70s. Good machinery scrap in cupola sizes is quiet at 70s. to 75s. No further alterations have taken place in the prices prevailing for the purchase and sale of scrap materials in the Midlands during the last week. The majority of sellers are, however, of the opinion that prices will improve as soon as some of the stocks which the works hold are depleted. For heavy steel scrap 55s. to 57s. 6d. per ton, delivered, is the best price offered by local works, and from an intrinsic point of view, compared with the price of basic pig-iron, this is certainly too low. Steel turnings are easy at 41s. to 43s. 6d. per ton, f.o.r. There is still a good demand for heavy cast-iron scrap, with good prices being offered; 85s. per ton delivered is realised without any difficulty. It is, however, expected that, when pig-iron becomes more plentiful, this price will depreciate. Light cast-iron scrap is firm at £3, f.o.r.

Metals.

Copper.—Recent developments in standard cash copper have been of a distinctly depressing character, and prices have fallen materially, particularly for refined metal, which was subject to unusually sharp price-cutting on the part of the Export Combine in order to counter outside competition. At the moment prices have rallied slightly. Considering the slump in refined copper, the market for warrant copper held up comparatively well, so that the margin between the two has been appreciably reduced. There has been, however, but little interest shown by consumers in consequence of the absence of confidence, although the fact that prices dropped to a low level will eventually be taken into consideration.

Official closing prices of standard copper have been as follow :—

Cash: Thursday, £53 17s. 6d. to £54; Friday, £53 17s. 6d. to £54; Monday, £55 to £55 2s. 6d.; Tuesday, £55 to £55 2s. 6d.; Wednesday, £55 5s. to £55 7s. 6d.

Three Months: Thursday, £54 10s. to £54 12s. 6d.; Friday, £54 8s. 9d. to £54 11s. 3d.; Monday, £55 10s. to £55 12s. 6d.; Tuesday, £55 10s. to £55 12s. 6d.; Wednesday, £55 17s. 6d. to £56.

Tin.—The standard cash tin market round February 9 was in a strong and excited state on buying from all quarters. America made extensive purchases in the East, where prices rose to a high level for the usual 60 days' shipment. Sentiment was rendered the more bullish by anticipations of short shipments from Malaya, current estimates being about 5,000 tons. Oversold parties were taken by surprise by the rapid rise from day to day, which carried the price of cash metal up several pounds. Three months' delivery, however, hesitated, and buyers then became more cautious, the price finally receding. The backwardness on three months' delivery was increased to near £14 per ton. This is reminiscent of what happened in the closing month of last year when the position of near tin was particularly stringent and home stocks very low. It is somewhat difficult to reconcile the heavy back with the high prices actually paid for shipment tin in the East.

Official closing prices of standard tin have been as under :—

Cash: Thursday, £306 5s. to £306 10s.; Friday, £308 to £308 5s.; Monday, £311 5s. to £311 10s.; Tuesday, £308 10s. to £308 15s.; Wednesday, £307 15s. to £308.

Three Months: Thursday, £295 10s. to £295 15s.; Friday, £297 to £297 5s.; Monday, £300 5s. to £300 10s.; Tuesday, £298 10s. to £298 15s.; Wednesday, £299 to £299 5s.

Spelter.—The demand for ordinary brands of spelter is disappointing, while the tonnage available is decidedly heavy. In fact, production has distinctly grown in excess of current needs, which may not be rectified yet awhile unless the outlet improves or restrictions are made on smelting operations. The American price is at well above the worst, and has been less influenced by adverse developments on this side.

The following are the week's prices :—

Ordinary: Thursday, £29 15s.; Friday, £30 2s. 6d.; Monday, £30 17s. 6d.; Tuesday, £30 7s. 6d.; Wednesday, £30 5s.

Lead.—In soft foreign lead the slight improved sentiment stimulated a good deal of bear covering and a certain amount of buying on the part of consumers, but otherwise the situation presents no appreciable change. The price certainly is generally regarded as low, and would respond readily to any improvement in the general situation, but meantime the outlook has not sufficiently improved to warrant sustained advance, and further upward tendency would, therefore, in all likelihood, result in renewed selling. The spring demand should be commencing to make itself felt; and as it expands, so will the accumulation of stocks in Europe and North America be more quickly absorbed.

The week's prices are appended :—

Soft foreign (prompt): Thursday, £27 2s. 6d.; Friday, £27 12s. 6d.; Monday, £28 2s. 6d.; Tuesday, £27 17s. 6d.; Wednesday, £27 17s. 6d.

Royal Agricultural Society of England.—The annual show of the Royal Agricultural Society will be held at Newport, Mon., on Tuesday, July 5, to Saturday, July 9, 1927. This year £14,701 will be offered in prizes.